Data Collection Ltd.

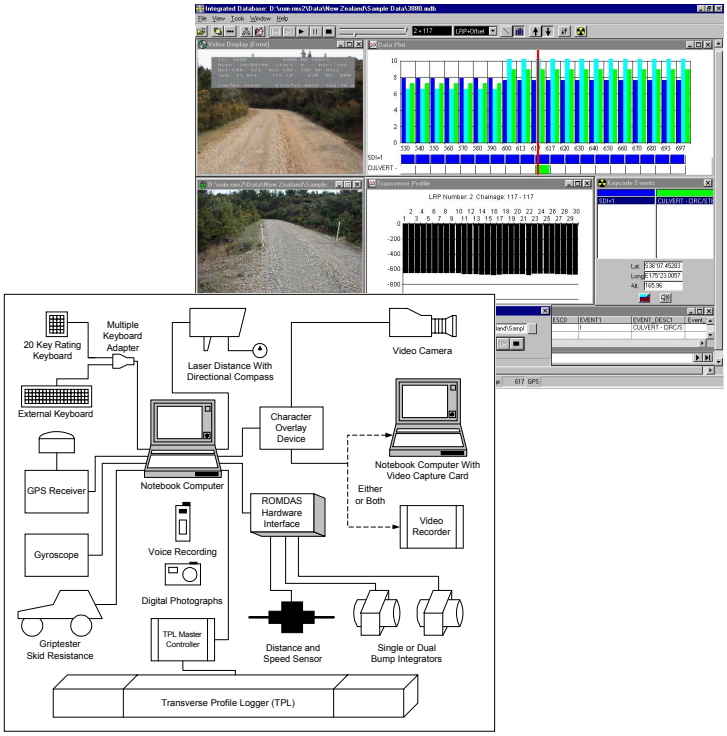
ROMDAS

ROAD MEASUREMENT DATA ACQUISITION SYSTEM

DATA COLLECTION SYSTEM USER'S GUIDE

Version 5.4a

September 2001



Data Collection Ltd.
P.O. Box 348
Motueka 7161
NEW ZEALAND

Ph: +64-3-528-8212
Fax: +64-3-528-8213
info@romdas.com
www.romdas.com

COPYRIGHT

The information in this document is subject to change without notice. All material in this document is subject to international copyright laws and may not be reproduced without written permission of Data Collection Ltd. Permission is granted to registered users of ROMDAS to print additional copies of the manual for their personal use. Brief extracts may be made from the manual for technical purposes as long as they are referenced. The reference to use is:

Bennett, C.R. (2001). *Road Measurement Data Acquisition System: ROMDAS User's Guide.* Data Collection Ltd, Motueka, New Zealand.

© 2001 Data Collection Ltd. All rights reserved.

Christopher R. Bennett has asserted his right to be identified as author of this work in accordance with the U.K. Copyright, Designs and Patents Act 1988. ROMDAS® is a registered trademark (U.K. Trademark 2103951).

Although this report is believed to be correct at the time of publication, Data Collection Ltd., its employees or agents involved in the preparation and publication of the report do not accept any contractual, tortious or other form of liability for its contents or any consequences arising from its use. People using the information contained in the report should apply, and rely upon, their own skill and judgment to a particular issue which they are considering.

Quality Assurance Statement	
File: E001	**Prepared by:** C.R. Bennett
Report Name: ROMDAS Data Collection System User's Guide	**Reviewed by:** P. Hunter
Version: 5.4a	**Approved for issue by:** C.R. Bennett
Date of Issue: 9 September 2001	**Project manager:** C.R. Bennett
File Name: D:\Files\E - ROMDAS Documentation\001 - ROMDAS Data Collection Manual\v53\v54a-1.doc	

Data Collection Ltd.
P.O. Box 348
Motueka, 7161
NEW ZEALAND
Phone: +64-3-528-8212
Fax: +64-3-528-8213
E-mail: info@romdas.com
Web: www.ROMDAS.com

 © 2001 Data Collection Ltd.

REVISIONS

Revision	Date	Section/Page	Description
5.3b7	5/02/01	Various	Updated manual for v 5.3a Build 7
5.3b7	25/3/01	Updated	Completed missing sections
5.4a	9/9/01	Updated	Minor updates for new version

© 2001 Data Collection Ltd.

CONTENTS

COPYRIGHT I

REVISIONS III

CONTENTS iv

LIST OF FIGURES x

LIST OF TABLES xiii

LIST OF IMPORTANT BOXES xiv

1. INTRODUCTION 1

2. PRINCIPLES OF ROAD MEASUREMENT 9

2.1 INTRODUCTION 9
2.2 TERMINOLOGY 9
2.3 LOCATION REFERENCE POINTS 9
2.4 DISTANCE MEASUREMENT ACCURACY 11
2.5 KEYBOARD EVENT RATING 12
2.6 SURVEYING ADJACENT SECTIONS 13

3. INSTALLATION OF ROMDAS IN VEHICLE 16

3.1 INTRODUCTION 16
3.2 INSTALLING ROMDAS HARDWARE INTERFACE 16
3.3 HARDWARE INTERFACE CONNECTIONS 18
3.4 POWER CONNECTIONS 20
3.5 BUMP INTEGRATOR CONNECTIONS 21
3.6 DISTANCE AND SPEED SENSOR CONNECTIONS 23
3.7 REVERSE OPTION 23
3.8 TRANSVERSE PROFILE LOGGER 23
3.9 VIDEO SYSTEM 23
3.10 CALIBRATION PROXIMITY SENSOR 24
3.11 USING ROMDAS IN MORE THAN ONE VEHICLE 25
3.12 IF SOMETHING GOES WRONG 25

4. INSTALLING AND STARTING THE ROMDAS SOFTWARE 29

4.1 INTRODUCTION 29
4.2 THE ROMDAS SOFTWARE 29
4.3 INSTALLING THE PROGRAM 29

 © 2001 Data Collection Ltd.

4.4 DIRECTORY STRUCTURE 31
4.5 TEST MODE/SURVEY MODE 32
4.6 SERIAL NUMBERS 34
4.7 THE FIRST TIME 34
4.8 SHELLING TO MS-DOS 35

5. SETTING UP THE ROMDAS SOFTWARE 36

5.1 INTRODUCTION 36
5.2 CALIBRATE 37
5.2.1 Calibrate Odometer 37
5.2.2 Calibrate Roughness Meter 38
5.2.3 Calibrate Transverse Profile Logger 38
5.3 EDIT DATA FILES 40
5.3.1 Edit Keycode Event Data 40
5.3.2 Roughness Calibration Coefficients 42
5.3.3 Survey Roughness Index Coefficients 44
5.3.4 Edit Road Definition Data 45
5.3.5 Edit LRP Definition Data 45
5.3.6 Edit Traffic Count Flow Profiles 46
5.3.7 Edit Elevation Profile Data for IRI 47
5.4 TRANSVERSE PROFILE LOGGER 48
5.4.1 Introduction 48
5.4.2 TPL Setup 48
5.4.3 TPL Analysis Options 51
5.4.4 TPL Error Corrections 52
5.4.5 Define Standard Conditions for Fixed Target 53
5.4.6 Check TPL Sensor Numbering 53
5.4.7 TPL Diagnostics 54
5.4.8 Crossfall Calculations 54
5.5 CUSTOMISE 56
5.5.1 Default Directory 56
5.5.2 Define Pause Key 56
5.5.3 Assign Mouse Buttons 57
5.5.4 Screen Colours 57
5.5.5 Remove Old Data 57
5.5.6 User Defined Fields 57
5.5.7 Custom Database Structures 58
5.5.8 Time Date Setting 58
5.6 OPTIONS 59
5.6.1 Program Settings 59
5.6.2 Roughness Surveys 61
5.6.3 Video Surveys 63
5.6.4 Location Reference Points 64
5.6.5 Keycode Settings 68
5.6.6 Access Settings 68
5.6.7 COMM Port and Printing 70
5.6.8 User Name 71
5.6.9 Password Setting 71
5.6.10 Local Languages 72
5.6.11 GPS 72
5.6.12 Skid Resistance 74
5.6.13 Moving Traffic Surveys 75
5.6.14 Laser Surveyor 76

 © 2001 Data Collection Ltd.

6. ROAD ROUGHNESS SURVEYS 78

6.1 INTRODUCTION 78
6.2 PREPARING FOR THE SURVEY 78
6.3 DEFINING SURVEY DATA 80
6.4 CONDUCTING A SURVEY 84
6.5 FILES 88

7. TRAVEL TIME AND CONGESTION SURVEYS 89

8. KEYBOARD RATING SURVEYS 91

9. LOCATION REFERENCE POINT SURVEYS 94

10. VIDEO SURVEYS 97

10.1 INTRODUCTION 97
10.2 SYSTEM SETUP AND OPERATION 97
10.3 DIRECT DIGITISATION 100
10.4 ROMDAS VIDEOPLAY 100

11. TRANSVERSE PROFILE SURVEYS 102

11.1 INTRODUCTION 102
11.2 ROMDAS TRANSVERSE PROFILE LOGGER 103
11.3 PROCESSING TPL DATA 105
11.4 ANALYSING TPL DATA 107
11.4.1 Introduction 107
11.4.2 Rut Depth Under a Straight-Edge 107
11.4.3 Pseudo-Rut Depths 110
11.5 VIEWING TRANSVERSE PROFILES 112

12. CROSSFALL SURVEYS 114

12.1 INTRODUCTION 114
12.2 PRINCIPLES OF CROSSFALL MEASUREMENT 114
12.3 CALCULATING ANGLE OF ROAD TO TPL/VEHICLE 116
12.3.1 Introduction 116
12.3.2 Regression 116
12.3.3 Elevations 117
12.4 ROLL CALIBRATION 117

13. GPS SURVEYS 118

13.1 INTRODUCTION 118
13.2 OVERVIEW OF GPS 118
13.3 GPS ACCURACY 119
13.4 ROMDAS GPS MEASUREMENTS 121
13.5 GPS DATA PROCESSING 121
13.6 GPS LASER SURVEYOR 123

 © 2001 Data Collection Ltd.

14. SKID RESISTANCE SURVEYS 125

14.1 INTRODUCTION 125
14.2 USING THE GRIPTESTER IN A SURVEY 125
14.3 DATA PROCESSING 126

15. MOVING TRAFFIC SURVEYS 128

15.1 INTRODUCTION 128
15.2 SETTING UP ROMDAS FOR MOVING TRAFFIC COUNTS 130
15.3 EXECUTING A MOVING TRAFFIC SURVEY 132
15.4 DATA PROCESSING 133

16. DIGITAL ODOMETER 134

17. DATA PROCESSING AND FILE MANAGEMENT 136

17.1 INTRODUCTION 136
17.2 DATA FILES 136
17.3 ROUGHNESS DATA 137
17.3.1 Edit Data Files 138
17.3.2 Calculate Roughness Using Calibration Equations 140
17.3.3 Extract Roughness Data 141
17.3.4 Extract Calibrated Roughness Data 142
17.3.5 Print Raw or Calibrated Roughness Data 142
17.3.6 Move Raw or Calibrated Roughness Data 142
17.3.7 Calculate IRI From Road Profile 143
17.4 TRAVEL TIME AND CONGESTION SURVEY DATA 143
17.5 KEYBOARD RATING DATA 144
17.6 LOCATION REFERENCE POINT DATA 145
17.7 TRANSVERSE PROFILE LOGGER DATA 145
17.8 GPS DATA 146
17.9 GRIPTESTER DATA 147
17.10 TRAFFIC COUNT DATA 147
17.11 MISCELLANEOUS DATA 147
17.11.1 Edit Keycode Event Data 148
17.11.2 Edit Roughness Calibration Coefficients 148
17.11.3 Print Roughness Calibration Coefficients 148
17.11.4 Edit Road Definition Data 148
17.11.5 Print Road Definition Data 148
17.11.6 Process Daily Survey Record 148
17.11.7 Print Daily Survey Log 148
17.11.8 Print Road Chainage Data 148
17.12 EXTRACT TO CUSTOM SYSTEMS 149
17.13 DELETE FILES 149

18. ROMDAS ROAD MANAGEMENT SYSTEM 150

18.1 INTRODUCTION 150
18.2 USING THE RMS 150
18.3 INTEGRATING DATA 151
18.4 CALIBRATING THE VIDEO 152
18.5 SURVEY MANAGEMENT 153
18.5.1 Combine Databases 153

 © 2001 Data Collection Ltd.

18.5.2 Creating LRP Files from Other Databases 153
18.5.3 Reversing LRP Directions.....154
18.5.4 Creating a Survey Route 154
18.5.5 LRP Chainage Evaluation 155
18.6 DISPLAYING THE DATA.....155
18.7 FUTURE DEVELOPMENTS 156

19. FUTURE DEVELOPMENTS AND CUSTOMISATION 157

20. LICENCE AND WARRANTY.....158

LIST OF ANNEXES 161

ANNEX A ROMDAS USER REGISTRATION FORM 162

ANNEX B PARTS LIST 163

ANNEX C SCHEMATIC DIAGRAMS OF ROMDAS CONNECTIONS.....165

ANNEX D ROMDAS CONNECTORS AND PARTS 169

ANNEX E DISTANCE/SPEED SENSOR INSTALLATION INSTRUCTIONS178

ANNEX F INSTALLATION OF ROUGHNESS METER.....187

ANNEX G TRANSVERSE PROFILE LOGGER.....193

ANNEX H INSTALLING THE ROMDAS VIDEO SYSTEM 201

ANNEX I FABRICATING A PROXIMITY SENSOR.....209

ANNEX J CALIBRATING A ROAD ROUGHNESS METER TO IRI.....211

ANNEX K TRAVEL TIME AND CONGESTION SURVEYS.....224

ANNEX L CUSTOM DATABASES.....231

 © 2001 Data Collection Ltd.

ANNEX M ROMDAS FILE STRUCTURES 236

Location Reference Point Data.....236
Roughness Survey Data 237
Keycode Survey Data 238
Survey Log Data.....240
Roughness Vehicle Calibration Coefficients 241
Calibrated Roughness Survey Results.....241
Speed Survey Data 242
Speed and Acceleration Profiles 243
Transverse Profile Data.....243
IRI Elevation Profile 244
Daily Survey Log.....246
Road Description Data 246
FILE STRUCTURES 247

ANNEX N STEP BY STEP INSTRUCTIONS.....252

INSTALLING THE HARDWARE.....252
SETTING UP THE ROMDAS SOFTWARE 252
PREPARING FOR SURVEYS.....253
ODOMETER CALIBRATION 253
CALIBRATING ROUGHNESS METER 254
TRANSVERSE PROFILE LOGGER - INITIAL SETUP 255
CALIBRATION OF TRANSVERSE PROFILE LOGGER 255
LOCATION REFERENCE POINT SURVEYS.....256
ROUGHNESS SURVEYS.....256
TRAVEL TIME AND CONGESTION SURVEYS.....257
KEYCODE SURVEYS.....258

ANNEX O PROBLEM SOLVING WITH ROMDAS 260

ANNEX P COMPUTER COMPATIBILITY ISSUES.....264

ANNEX Q ROMDAS CIRCUIT DIAGRAM 267

ANNEX R PCMCIA SERIAL CARDS.....268

ANNEX S PREPARING A BOOT MENU FOR USE WITH ROMDAS 274

ANNEX T PROGRAMING THE RATING KEYBOARD 277

ANNEX U CREATING A SHORTCUT TO ROMDAS UNDER WINDOWS.....279

 © 2001 Data Collection Ltd.

LIST OF FIGURES

Figure 1.1: ROMDAS System 2
Figure 1.2: ROMDAS Hardware Interface 3
Figure 1.3: Basic ROMDAS System in Case 3
Figure 1.4: DCL New Zealand ROMDAS Vehicle 4
Figure 1.5: Advanced Road Technologies Sdn. Bhd. ROMDAS Vehicle 4
Figure 2.1: Implications of LRP Resets on Survey Chainages 10
Figure 2.2: Example of Labelling 58 Key Rating Keyboard 13
Figure 3.1: ROMDAS Connections 17
Figure 3.2: ROMDAS Connections – Single Video Camera 18
Figure 3.3: ROMDAS Power Switch 20
Figure 3.4: Half or Quarter-Car Roughness Meter Installations 22
Figure 3.5: ROMDAS Video System 24
Figure 3.6: ROMDAS Tester 25
Figure 3.7: Example of Successful RDASTEST Test Run – v 3 Interface 28
Figure 4.1: ROMDAS Directory Structure and Contents 33
Figure 4.2: Opening Menu 35
Figure 5.1: Setup Menu 36
Figure 5.2: Datum Level Corrections 39
Figure 5.3: Edit Keycode File Screen 41
Figure 5.4: Screen for Defining Roughness Calibration Coefficient Files 43
Figure 5.5: Roughness Calibration Equation Coefficients 44
Figure 5.6: Survey Roughness Index Coefficients 45
Figure 5.7: LRP Definition File 46
Figure 5.8: ADT Flow Profile 46
Figure 5.9: AADT Flow Profile 47
Figure 5.10: Editing Elevation Profile Data 48
Figure 5.11: TPL Options 49
Figure 5.12: Transverse Profile Logger Setup Screen 49
Figure 5.13: TPL Analysis Options 51
Figure 5.14: TPL Error Corrections 53
Figure 5.15: Crossfall Calculation Options 55
Figure 5.16: Default Directory Options 56
Figure 5.17: Display for Defining Pause Key 57
Figure 5.18: User Defined Fields 58
Figure 5.19: Options Menu 59

 © 2001 Data Collection Ltd.

Figure 5.20: Program Settings Menu....60
Figure 5.21: Roughness Survey Settings....61
Figure 5.22: Video Survey Settings....63
Figure 5.23: Location Reference Point Options....65
Figure 5.24: Example of Survey With Reset Chainage....67
Figure 5.25: Example of Survey With Cumulative Chainage....67
Figure 5.26: Example of Survey with Cumulative Chainage and Reset....68
Figure 5.27: Access Settings Menu....69
Figure 5.28: Standard COM Port Settings....71
Figure 5.29: Local Language Definition....72
Figure 5.30: GPS Setup Options....73
Figure 5.31: GripTester Data Input Screen....75
Figure 5.32: Moving Traffic Survey Data....76
Figure 5.33: Laser Surveyor Data Entry System....76
Figure 6.1: Roughness Survey Screen....81
Figure 6.2: Display During Roughness Survey....84
Figure 6.3: Example of Recording On 'Other Side' of the Road....87
Figure 7.1: Speed Survey Opening Screen....89
Figure 7.2: Speed Survey Display....90
Figure 8.1: Keyboard Rating Survey Opening Screen....92
Figure 8.2: Display During Keyboard Rating Survey....92
Figure 9.1: Location Reference Point Survey....95
Figure 9.2: LRP Locations Using Laser Surveyor....96
Figure 10.1: Example of Reduced Video Display - Small Fonts....97
Figure 10.2: Example of Reduced Video Display - Large Fonts....98
Figure 10.3: Example of Digitised Video Frame....100
Figure 11.1: Firing Sequence of Transverse Profile Logger....104
Figure 11.2: Transverse Profile Measurement Locations....105
Figure 11.3: Calculating Rut Depth from Transverse Profile....108
Figure 11.4: Example of Calculating Rut Depth....109
Figure 11.5: Pavement Distortion Possibilities....111
Figure 11.6: Definition of Pseudo-Ruts....112
Figure 11.7: Example of ROMDAS Profile Viewer Display....112
Figure 12.1: Crossfall Measurement Components....114
Figure 12.2: Example of Crossfall Calculations—Case 1....115
Figure 12.3: Example of Crossfall Calculations—Case 2....115
Figure 12.4: Example of Crossfall Calculations—Case 3....115
Figure 12.5: Example of Regression Analysis....116

 © 2001 Data Collection Ltd.

Figure 12.6: Example of Irregular Pavement....117
Figure 13.1: Satellite Triangulation....119
Figure 13.2: Geometrical Dilution of Precision....120
Figure 13.3: ROMDAS GPS Data Processing....122
Figure 13.4: Laser Advantage Laser Surveyor....123
Figure 14.1: Findlay Irvine GripTester....125
Figure 14.2: GripTester Survey Data Entry Screen....126
Figure 15.1: Example of Moving vs 7-Day ADT from India....130
Figure 15.2: Example of Daily Flow Profile....131
Figure 15.3: AADT Seasonal Correction Factors from Gujarat, India....132
Figure 16.1: Digital Odometer Display....134
Figure 17.1: Data Management Menu....136
Figure 17.2: Edit Data Files Menu....138
Figure 17.3: File Viewing Menu....139
Figure 17.4: Section Data Example....140
Figure 17.5: Selecting Roughness Calibration Equations....141
Figure 17.6: Travel Time and Congestion Survey Data Management Menu....143
Figure 17.7: Keyboard Rating Data Menu....144
Figure 17.8: LRP Data Management Menu....145
Figure 17.9: Transverse Profile Data Management Menu....146
Figure 17.10: GPS Data Management Menu....146
Figure 17.11: Miscellaneous Data Management Menu....147
Figure 18.1: Data Integration Input Files....151
Figure 18.2: Example of Video Calibration Screen....152
Figure 18.3: RMS Roughness Bar and Line Graph Displays....154
Figure 18.4: RMS Roughness Bar and Line Graph Displays....155
Figure 18.5: Example of Full RMS Display....156

 © 2001 Data Collection Ltd.

LIST OF TABLES

Table 6.1: ROMDAS Survey Instructions from India 80
Table 11.1: Firing Distance as Function of Speed 105
Table 13.1: Standard vs Differential GPS Errors 120
Table 17.1: ROMDAS Data File Prefixes 137
Table 17.2: Description of RECTYPE Values 138

 © 2001 Data Collection Ltd.

LIST OF IMPORTANT BOXES

ROMDAS DOCUMENTATION 2
Hardware Limitations 7
ROMDAS Versions 8
Before You Go Any Further 8
Multiple Keyboards 15
Potential Incompatibilities for Video System 24
Conflicts 30
When to Use Test Mode or Survey Mode 34
Before You Do Anything Else 36
Important Advice 69
Roughness Display 78
An Easier Way 84
Problems? 85
Using a Mouse 86
In Case of Error 87
Your First Survey 88
Accuracy of Surveys 90
Rating and Defining LRPs In One Survey 91
If You Are Using LRP Resets 92
Laser Surveyor 93
Digital Photographs 94
Laser Surveyor 95
If You Are Using LRP Resets 96
False Economy 97
Transparent Overlay Background 98
Large Fonts 99
Multiple Cameras: The Recommended Way 99
Development of TPL 103
Real Time Corrections 121
GripTester Distance Measurement 126
Using a Mouse 132
Problems Deleting Files 142
Accuracy of Surveys 144
Trying the RMS 150

 © 2001 Data Collection Ltd.

 © 2001 Data Collection Ltd.

ROMDAS

ROAD MEASUREMENT DATA ACQUISITION SYSTEM

USER'S GUIDE

Version 5.4a

1. INTRODUCTION

The "ROad Measurement Data Acquisition System" (ROMDAS) has been developed by Data Collection Ltd. (DCL) as a generic system for collecting data on road condition and travel time.

It is possible to use ROMDAS for:

- roughness surveys;
- travel time and congestion surveys;
- condition rating surveys;
- inventory surveys;
- moving traffic surveys;
- transverse profile/rutting surveys;
- video log surveys;
- recording the location of digital photographs;
- creating voice records which are associated with road attributes;
- collecting global positioning system (GPS) data;
- collecting skid resistance data using the Findlay Irvine GripTester;
- as a digital trip meter.

ROMDAS uses an Intel based[1] IBM compatible laptop or notebook PC to store all the data and to interact with the instruments.

The ROMDAS system is illustrated in Figure 1.1.

[1] Problems have been reported with non-Intel based systems such as the AMD K6. These are not 100% IBM PC compatible and ROMDAS will probably not work correctly. This problem is not just confined to ROMDAS but has been reported with other software and peripherals using Cyrix and AMD chips. See ANNEX P (page 264) for a list of computers which have been reported compatible with ROMDAS and other computer compatibility issues.

© 2001Data Collections Ltd..

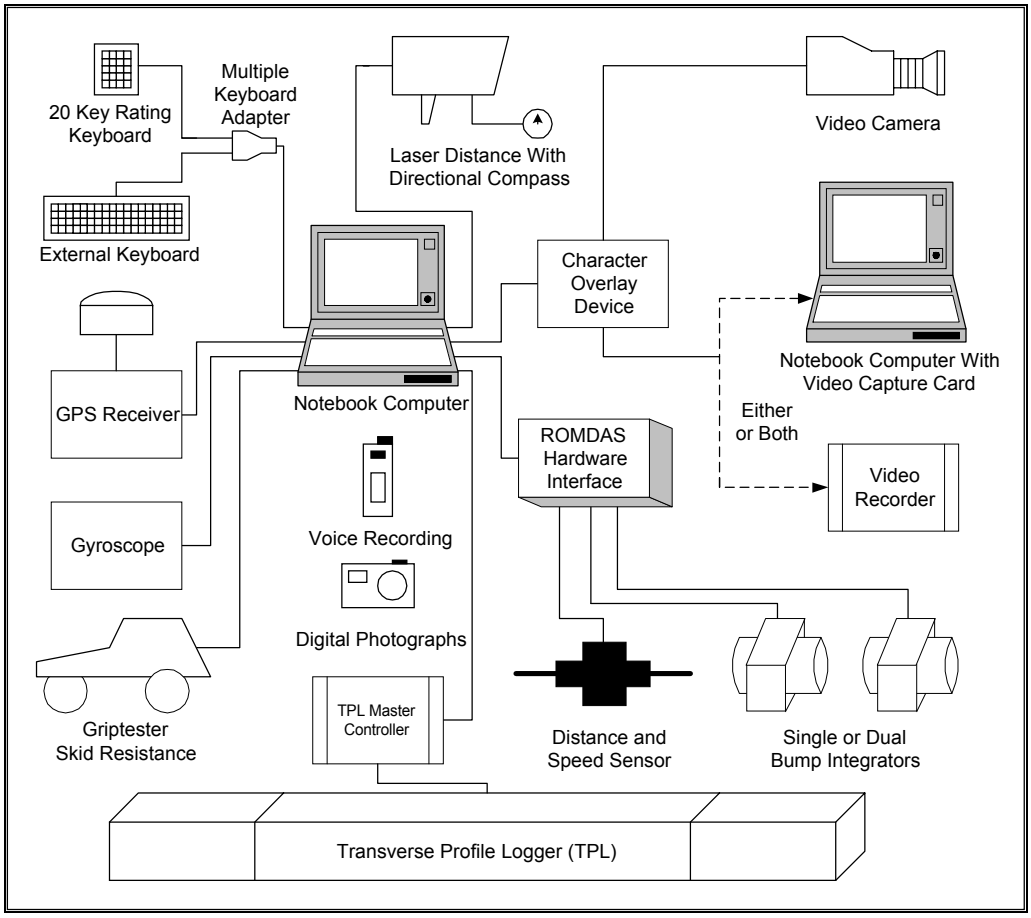


Figure 1.1: ROMDAS System

Box 1.1 ROMDAS DOCUMENTATION

The following ROMDAS documentation is available:

DCS Manual	❑ This manual. Describes the operation of the ROMDAS data collection software
Installation Guide	❑ Detailed instructions on installing ROMDAS hardware to a vehicle
Quality and Management Plan	❑ Describes the survey procedures used by DCL for its ROMDAS surveys.
VCTS User's Guide	❑ Describes the operation of the ROMDAS video control trigger software
RMS User's Guide	❑ Describes the operation of the ROMDAS Road Management System

These, along with other documents such as working papers on the development of the ROMDAS instruments, are available on the ROMDAS CD or our web site at www.ROMDAS.com.

The basic ROMDAS system consists of:

© 2001Data Collections Ltd..

- a hardware interface;
- a digital distance/speed sensor which is spliced into the vehicle speedometer cable or attached to an electronic speedometer harness;
- all necessary electrical plugs/sockets and cabling (harness);
- PC software.

Figure 1.2 shows the v 5 hardware interface. Figure 1.3 shows the full system with bump integrator packed in its shipping case. The system is very portable and can easily be carried as hand luggage.

Figure 1.2: ROMDAS Hardware Interface

Figure 1.3: Basic ROMDAS System in Case

The hardware interface connects to a sensor on the roughness meter and to the distance/speed sensor. During the survey, the interface monitors both the distance/speed sensor and the roughness meter. Every 0.1 s, the PC interrogates the interface and records the data. At the end of the survey the data are stored in dBASE-III compatible files.

© 2001Data Collections Ltd..

The only permanent fixture in the vehicle is the distance/speed sensor. It is therefore practical to move ROMDAS between vehicles as long as they are fitted with a distance/speed sensor and harness. Since ROMDAS uses a portable computer as the data logger, the computer may also be used for other activities in between surveys[1].

ROMDAS has been installed in a variety of vehicle types, from passenger cars to utilities to four-wheel drive vehicles. Figure 1.4 shows the ROMDAS system operated by DCL for research and development in New Zealand.; Figure 1.5 a ROMDAS vehicle operated in Malaysia by Advanced Road Technologies Sdn. Bhd.

Figure 1.4: DCL New Zealand ROMDAS Vehicle

Figure 1.5: Advanced Road Technologies Sdn. Bhd. ROMDAS Vehicle

The following are the types of data that can be collected with ROMDAS:

[1] See ANNEX P (page 264) for a list of computers which have been reported compatible with ROMDAS and other computer compatibility issues.

© 2001Data Collections Ltd..

- **Roughness:** A response-type roughness meter can be added to measure road roughness. ROMDAS will convert raw roughness data into calibrated roughnesses through user-supplied equations. If equations are available for different speeds, ROMDAS will apply the appropriate equation given the vehicle speed at the time of the measurement. This removes the constraint of trying to operate the vehicle at a single survey speed under all conditions. If the only requirement is a simple roughness survey, ROMDAS can be run by the driver alone, eliminating the need for an additional operator. A single roughness meter can be used if the vehicle has a rear axle (half-car roughness); one or two roughness meters if independent rear suspension (quarter-car roughness).

- **Visual Condition and Inventory:** Condition and inventory surveys can be done using the computer keyboard. It is possible to assign any key to an event and these are recorded as point and continuous events. Using a special adapter available from DCL it is possible to connect multiple keyboards to the notebook computer. This makes it possible to have several observers performing rating at the same time—for example one doing condition and a second inventory. There is also a special 20 or 58 key rating keyboards which are ideal for condition surveys. Groups of keys can be assigned to an individual distresses or roadside events.

  If it is necessary to establish the exact locations of certain attributes—for example km posts or signs—the ROMDAS Laser Surveyor option can be used. This sees a laser range finder with integrated compass and inclinometer used to establish the exact position of the attribute relative to the vehicle. If GPS is being recorded in the survey the geo-coordinates of the attribute can be determined with a high degree of accuracy.

- **Rut Depth and Crossfall:** A 'Transverse Profile Logger' is available which can be used to measure the pavement transverse profile elevations using ultrasonics and to establish the rut depth. This instrument stores raw elevation data which are downloaded to the PC after the survey to calculate the rut depth under a user-definable straight edge. The transverse profile distortion is used to estimate potential causes of rutting. A dual gyroscope system has been developed which is used at the same time to collect data on the vehicle heading, pitch and roll. These data are used to estimate the pavement crossfall. There is a standalone Windows 95 application which allows you to review, copy and plot the transverse profile data.

- **Video Logging:** A camcorder or video recorder can be used to record data on the pavement right-of-way or the surface. This is connected to the computer video port through a character overlay device which superimposes the survey chainage and other basic data on the tape. These images can be saved to the computer using inexpensive hardware to be inserted into reports or as images to databases. A video workstation digitises the data and can be used to extract specific frames for storage or future retrieval. Up to 5 cameras and recorders can be used simultaneously.

- **GPS Centreline:** When used with a GPS receiver, ROMDAS will record the global positioning data as user defined sampling intervals (> 1 s). If the receiver has differential correction capabilities these are used to correct for selective availability. A gyroscope can be fitted to estimate the location when there is a loss of satellite lock.

- **Travel Time:** Travel time and congestion surveys can be conducted using ROMDAS. These will give the travel time, distances travelled and acceleration on a second-by-second basis. The system has been specifically designed to collect data for use in the World Bank's HDM-4 congestion model.

- **Traffic Volume:** ROMDAS can be used to perform 'moving traffic surveys'. These entail recording every vehicle which passes the survey vehicle. The data are used to establish and estimate of the AADT.

© 2001Data Collections Ltd..

- **Skid Resistance:** Skid resistance data can be collected using the GripTester produced by Findlay Irvine in Scotland[1]. ROMDAS stores the GripTester data and performs the same analyses as the original GripTester to determine the Grip and SCRIM numbers.

- **Digital Photographs of Roadside Events:** During ROMDAS surveys data can also be collected using a digital camera. Typically, this consists of photographs of roadside objects such as inventory items or km stones. The frame number corresponding to the image is entered to ROMDAS which associates a chainage with the photograph.

- **Voice Recordings:** Voice messages can also be recorded. These are associated with a chainage in the same way as digital photographs.

The optional ROMDAS RMS will play back all the survey data, including digital photographs and digitised voice files.

This guide describes the installation and operation of ROMDAS. It should be read in its entirety **BEFORE** installing ROMDAS in a vehicle. The operators should also familiarise themselves with the ROMDAS operation using its 'Test Mode' before commencing a survey.

NOTE: This guide contains a number of screen shots of the ROMDAS software. These may have been altered slightly in the program as the software is refined or enhanced over time. A file called README.TXT is included with the software. This contains information not included in the manual and should be read before installing or running the system.

The ROMDAS web site contains the current versions of the software, this manual, as well as utility programs. There are also photos of ROMDAS vehicles operated in different countries. The site can be found at:

http://www.ROMDAS.com

Support for the system is available via e-mail at:

support@romdas.com

We recommend using e-mail for technical enquiries since that offers the quickest turnaround for us.

[1] Findlay Irvine Ltd., Bog Road, Penicuik, Midlothian EH269BU, SCOTLAND. Phone: +44-1968-672-111; Fax: 44-1968-672-596.

© 2001Data Collections Ltd..

Box 1.2 Hardware Limitations

COMPUTER COMPATIBILITY: See ANNEX P (page 264) for a list of computers which have been reported compatible with ROMDAS and other computer compatibility issues. We only recommend Intel® based PCs for use with ROMDAS. It will run on 486 computers and upwards.

SERIAL PORTS: ROMDAS uses the serial port to communicate with the instruments. Most notebook computers only have a single serial port so this is used by the ROMDAS hardware interface. To use additional instruments (*i.e.* TPL, GPS or GripTester) it is usually necessary to install an additional serial port. This is usually done using single, dual or quad port PCMCIA cards manufactured by Socket IO or Quatech. DCL can supply these accessories. ANNEX R (page 268) describes how these devices are installed.

VIDEO PORT: To use the ROMDAS video system successfully your PC must support the simultaneous use of the PC display and an external monitor. Most have this feature. It is also important that the computer have drivers which give the full screen display (often called 'stretched mode') when running under MS-DOS. Those without this feature will have a square black band approximately 50 mm wide around the perimeter. This makes it impossible to locate the data header in the optimum position. For use of the large fonts the display adapter should support CGA mode.

WINDOWS 95. Although it is an MS-DOS application, ROMDAS is best run under Windows 95 since that will manage the computers memory. When using PCMCIA serial cards to access different ports these must be loaded through Windows and not using their own DOS based enablers. If you must use DOS enablers, the system must be booted to MS-DOS and not through windows. peripheral cards, such as PCMCIA serial must be run as an MS-DOS application. See ANNEX P (page 264) for a discussion on memory issues.

WINDOWS 98. In general, ROMDAS will run under Windows 98 reliably. However, problems have been identified with some Toshiba notebooks due to their power management. See ANNEX P (page 264) for how the Windows 98 registry can be modified to correct for this.

WINDOWS NT. ROMDAS will run under Windows NT from v 4.1b onwards.

WINDOWS ME. ROMDAS does not work Windows ME. Don't blame us … blame Microsoft.

Windows 2000. ROMDAS has not been tested with Windows 2000.

© 2001Data Collections Ltd..

Box 1.3 ROMDAS Versions

There are three versions of the ROMDAS software:

- Roughness Surveys (7000 Series)
- Travel Time Surveys (8000 Series)
- Roughness and Travel Time Surveys (9000 Series)

There are five versions of the ROMDAS hardware:

- Version 1 Hardware Prototype (1988)
- Version 2 Hardware Interface (Pre-1996)
- Version 3 Hardware Interface (Post-1996)
- Version 4 Hardware Interface (1998-99)
- Version 5 Hardware Interface (1999 Onwards)

Originally, different software versions were available for the v 2 and v 3 hardware interfaces (*e.g.* 2.5a and 3.5a). With v 4 these differences were been done away with and there is only a single version of the software which caters for all hardware interfaces and all survey types.

The user defines the hardware version under the software setup (**SETUP|OPTIONS|PROGRAM SETTINGS**) and ROMDAS internally reconciles the communication requirements for the hardware being used.

The default setup is for v 5 which uses the ROMDAS BI and the ROMDAS high resolution DMI.

The Roughness and Travel Time Surveys are password protected. You are provided with a password depending on which system you purchased. The optional surveys—traffic, video, GPS, skid resistance, laser surveyor, TPL—are also password protected.

Box 1.4 Before You Go Any Further

1. Please read the licence and warranty details in Chapter 20. If these are unacceptable return the uninstalled unit. Your payment will be refunded less shipping charges.

2. Please ensure that you register your ROMDAS. A registration form is given in ANNEX A. This information is required to ensure that you are sent any bug fixes and are notified of updates.

3. **IF YOU DON'T WANT TO READ THE MANUAL**. ANNEX N contains a series of 'step-by-step' instructions to get started. Please at least read Chapter 3 on properly installing ROMDAS.

© 2001Data Collections Ltd..

2. PRINCIPLES OF ROAD MEASUREMENT

2.1 INTRODUCTION

Before describing the ROMDAS and its features, it is important to appreciate some of the principles of road measurement. A proper understanding of these principles will ensure that the ROMDAS system is used to its full potential.

2.2 TERMINOLOGY

The following terminology is employed in this User's Guide:

- **Chainage** - the location along a road from a start point (in m).
- **LRP** - location reference point. A permanent marker or feature adjacent to the road used as a reference point for surveys.
- **Keyboard rating** - recording events with the PC keyboard.
- **Continuous event** - an event on, or adjacent to, the road which applies over a section of the road (e.g. a cracked section)
- **Point event** - an event on or adjacent to the road which applies to a point (e.g. a traffic sign or culvert).
- **Sampling interval** - the interval over which data are recorded. It is usually 100 - 1000 m for roughness surveys.
- **Transverse profile** - the pavement profile across a lane.
- **Longitudinal profile** - the pavement profile along a lane.

2.3 LOCATION REFERENCE POINTS

When conducting a survey, be it of road roughness, pavement condition, or roadside events, the most important single consideration is the location referencing system. The location referencing system used with ROMDAS is a linear system, that is, the survey starts at a given point and progresses along the road. Thus, the survey chainage increases when driving away from the start point and decreases when heading back along the same road towards the start point.

Surveys are always done between a start and end point. The common practice is often to only record these two chainages, however, this is inadvisable. No matter how well calibrated a distance/speed sensor is, there will be variations in the lengths recorded between different surveys on the same road. This will create problems in reconciling data.

A better approach is to have regular Location Reference Points (LRPs) along the road. These can be existing km stones, culverts, buildings, signs, or any physical feature which will not change between surveys. By selecting LRPs at regular intervals, generally 1 km, one minimises the errors between different surveys, particularly those conducted in successive years. This is done by resetting the chainage at each LRP thereby expressing all data in terms of the offset from the last LRP.

To illustrate the importance of using LRPs and resetting the chainages at each LRP, consider Figure 2.1. This consists of a road which has been accurately surveyed and has LRPs at 1000 m and 2000 m.

© 2001Data Collections Ltd..

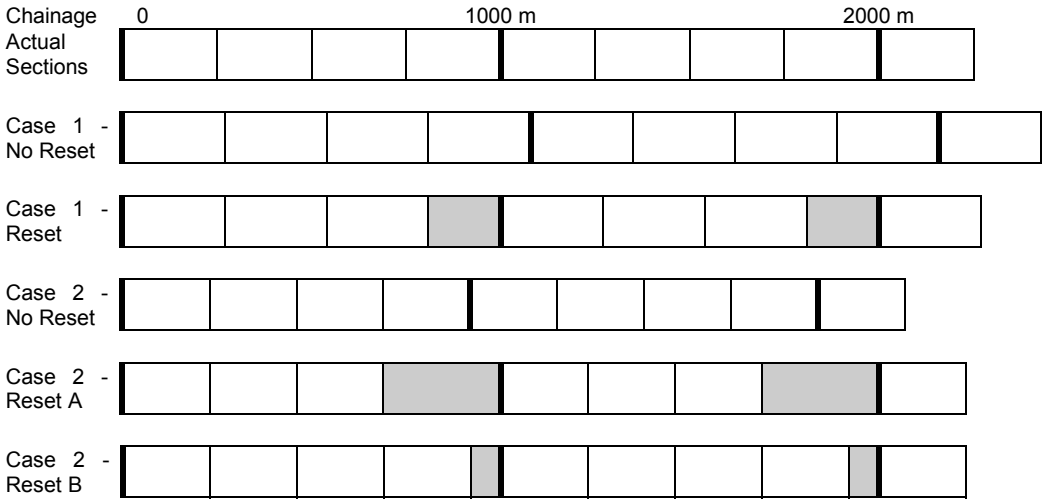


Figure 2.1: Implications of LRP Resets on Survey Chainages

No matter how well calibrated the odometer is, it will never read exactly the same in two surveys of the same road. This applies not only to the ROMDAS, but to any distance measuring device. Proper calibration limits these effects, but they can never be eliminated. Thus, in each subsequent survey the sections will not be identical, with the chainage errors accumulating as one travels along the road.

In Case 1, the odometer is underestimating the distance. As a consequence, the actual sampling intervals are greater than the target 250 m. At the first LRP there is only a small difference, however, as one continues along the road the errors accumulate so one eventually has the target segments completely out of synchronisation with the actual segments.

However, were one using LRP resets the errors would not accumulate and would only pertain to the last sampling interval. This is illustrated in Figure 2.1 under "Case 1 - Reset" where the final sampling interval before the LRP reset is shorter than the others. At each LRP the data are resynchronised thereby ensuring that the errors are confined to each section. It is also important to note that the data, for example the roughness, is calculated on the actual distance measured so the value will be representative of that actual segment, even though they are measured on a shorter segment.

Case 2 arises when the odometer is over-estimating the chainage. As in Case 1, the error accumulates so the sections are soon unsynchronised. In this instance, ROMDAS synchronises the sections depending upon the distance after the last sampling interval when the LRP is recorded. Two situations arise:

- the user can specify a distance after the LRP to increment to the next LRP. By default, this is set at 100 per cent of the sampling interval. If the LRP is recorded within this zone, the data will be stored as in "Case 2 - Reset A";
- if the LRP is not recorded within this zone, the data are recorded as "Case 2 - Reset B".

To illustrate the importance of resetting chainages at LRPs, consider the following example from a typical (and real life) odometer calibration. Three runs were made with the vehicle over a 200 m section. The number of odometer pulses recorded were 973, 975 and 977 over the section. These corresponded to 4865, 4875 and 4885 pulses per km. Assuming that the mean of 4875 is appropriate, the following is the distances that would have arisen with each of these values:

© 2001Data Collections Ltd..

Distance in km	Distance that Would Have Been Recorded in Surveys by Calibration Factor		
	4865	4875	4885
1.00	1.00	1.00	1.00
2.00	2.00	2.00	2.00
3.00	3.01	3.00	2.99
4.00	4.01	4.00	3.99
5.00	5.01	5.00	4.99
10.00	10.02	10.00	9.98
15.00	15.03	15.00	14.97
20.00	20.04	20.00	19.96
25.00	25.05	25.00	24.95
30.00	30.06	30.00	29.94
35.00	35.07	35.00	34.93
40.00	40.08	40.00	39.92
45.00	45.09	45.00	44.91
50.00	50.10	50.00	49.90

The above data show that the small difference of 2 pulses over 200 m can translate into an error of 100 m over 50 km. Over short distances, such as are used with LRP resets, the error is small enough to be ignored.

The importance of using LRP resets cannot be overemphasised. Highway agencies which do not use these invariably have problems reconciling their data from year to year. Many have to resort to sophisticated (or not so sophisticated!) processing algorithms ("rubber banding"), while others simply give up in frustration. ROMDAS has been designed in such a way that you can easily avoid these problems. Because of that we **STRONGLY** recommend the use of LRP resets.

ROMDAS has been designed to make full use of LRPs. The software will let the user supply a file containing a list of LRPs and their chainages, as recorded in a previous survey. As the survey progresses, the ROMDAS informs the operator that the vehicle is approaching an LRP established in a previous survey along with a description of the LRP. The operator will then press the ESC key when the vehicle is adjacent to the LRP. The recording is then reset thereby ensuring that the data corresponds exactly to the measurements made in previous surveys. The end chainages can be synchronised by replacing the surveyed chainage with the measured chainage from the LRP survey. It is also possible to insert new LRPs into an existing file or even to create an entirely new LRP file during a survey.

It is recommended that the chainages of the LRPs be established either in a separate survey or during the first roughness survey. These LRPs can then be used in all future surveys to ensure sampling consistency.

2.4 DISTANCE MEASUREMENT ACCURACY

The above discussion of LRPs touched upon the issue of measurement accuracy. It must be appreciated that the accuracy of your distance measurement is directly proportional to the number of pulses measured per km. Typically, vehicles generate 2000 - 5000 pulses/km. This corresponds to 0.5 - 0.2 m/pulse which is adequate for most applications.

The exception to this is when looking at acceleration behaviour in travel time surveys. Unless there is approximately 5000 pulses/km one finds that the results are insufficiently

© 2001Data Collections Ltd..

accurate to get a good estimate of the acceleration behaviour. The ROMDAS high accuracy distance measurement instrument is available for situations where high resolutions are required.

2.5 KEYBOARD EVENT RATING

The principle behind keyboard rating is to use the survey vehicle to establish the chainage of features, pavement condition or other roadside events.

Before undertaking keyboard rating it is necessary to break down the items to be measured into point and continuous events:

- a **point event** is something which exists at a single point in space, such as traffic signs or LRPs; or,
- a **continuous event** is something which exists over a section, such as pavement condition. Continuous events have two chainages: a beginning and end chainage.

There is a special type of continuous event called a **switch** event. This can be understood as a series of continuous events. For example, one may define a ranking for pavement condition from 0 to 5. These are continuous events so one would normally have to press two keys when changing; one to end the previous condition and one to apply to the new condition. Switch events remove the need to press two keys. When the second key is pressed the first event is cancelled[1].

It is necessary to allocate an individual key on the computer keyboard to each event. These should be carefully selected so as to be both easily accessible and easy to remember. It is good practice to tape small labels to the keys identifying the event.

When recording pavement condition it is recommended that the severity of the event also be recorded. This is done by allocating several keys to the same event, each with differing severities, for example:

Key	*Description*
A	No cracks
S	Low cracking
D	High Cracking
F	Extreme Cracking

It is strongly advised that any severity rating system must include a 'no defect' condition since many models which use condition data have different functions for 'no' versus 'some' distresses.

There are special 20 or 58 ROMDAS rating keyboards available which are designed to facilitate condition rating surveys. The photo to the right is the 20 key which has 5 rows and 4 columns. Each key can be individually programmed to any key on the computer keyboard. For example, one can assign different distresses to the rows and different severities to the columns. This greatly simplifies the correct identification of the key to press for a distress. For inventory surveys the keys could be labelled with different inventory items. Figure 2.2 is an example of how a 58 key rating keyboard could be labelled to collect different data. Here, the condition is being expressed in terms of the Surface Integrity Index which is a 0 to 5 scale[2].

[1] Normally, one has events that apply continuously along a section of road. For example, there will always be either no cracking or a level of cracking. ROMDAS defaults to having the user switch only between switch events; the cannot have 'no' event. However, this can be overruled in the keycode event setup screen.

[2] Paterson, W.D.O. (1993). *A Standard Surface integrity Index of Pavement Condition: Definition and Measurement Procedure*. Internal Paper, The World Bank, Washington, D.C.

© 2001Data Collections Ltd..

20 Key Rating Keyboard

58 Key Rating Keyboard

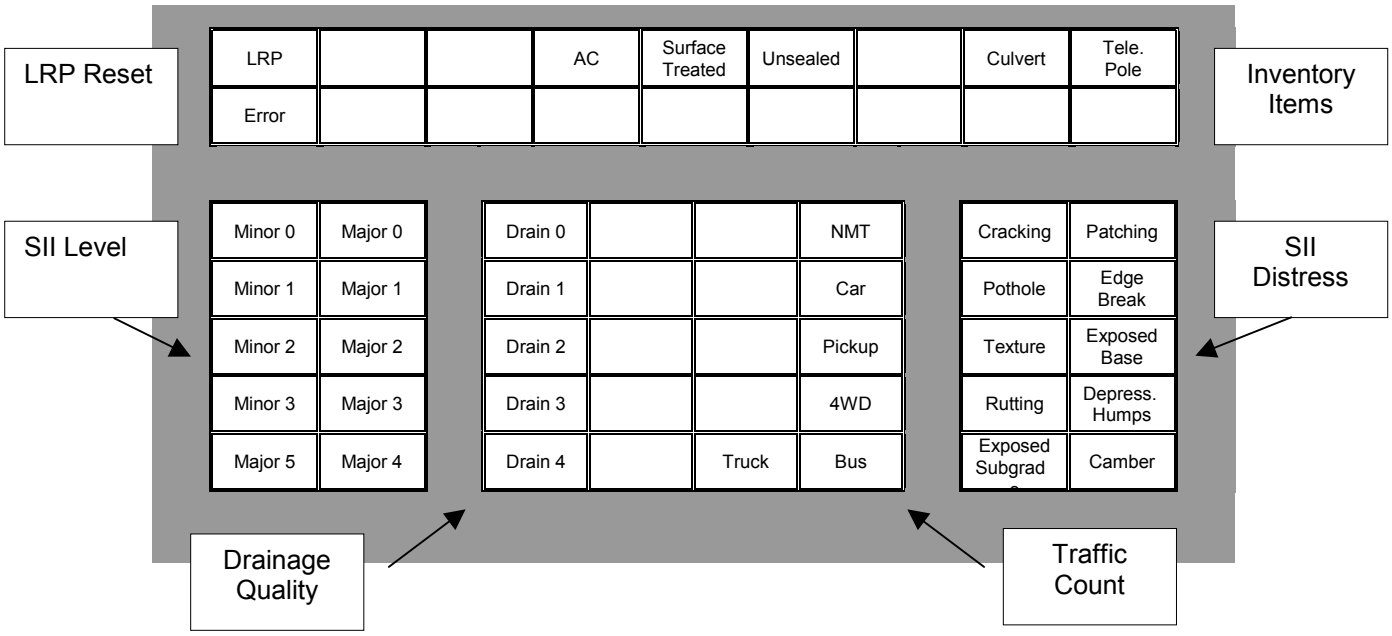


Figure 2.2: Example of Labelling 58 Key Rating Keyboard

When selecting the number of distresses to record, and their severities, always bear in mind the practical limitations of the operator. The greater the number to record the more difficult it is to get reliable and repeatable results.

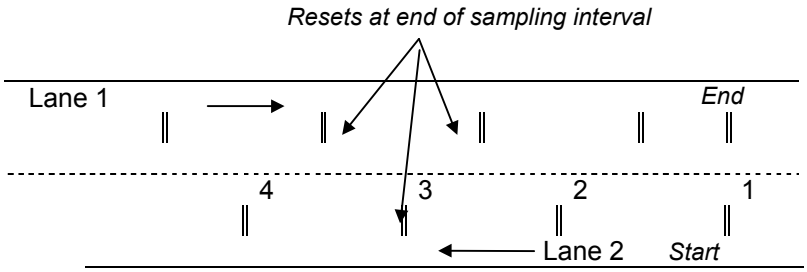
It is possible to define keycode events **before** the survey actually starts. This allows the operators to define the events so that they are initialised as soon as the survey begins.

2.6 SURVEYING ADJACENT SECTIONS

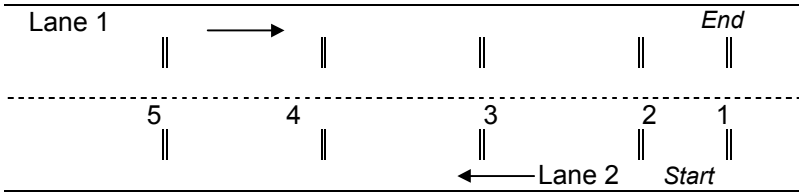
A problem can often arise when measuring two adjacent lanes on a two-lane road. When the survey of the first lane is completed the vehicle must be turned around to measure the second lane. Roughness is measured over regular sampling intervals but the last interval is usually of a shorter length than the sampling interval. When measuring the roughness in the second lane unless the first interval length is the same as the last interval for the previous lane, the survey results will be staggered and not correspond to exactly adjacent sections. This problem can be visualised below under (a).

ROMDAS allows the user to terminate a survey, reposition the vehicle and start the survey on the other lane. It adjusts the first interval length so that it is the same as the last interval for the previous lane. This ensures that the results of a roughness survey apply to adjacent samples. This is illustrated below under (b)

© 2001Data Collections Ltd..



(a) Example of Adjacent Lanes With Shortened Interval at End of First Lane



(b) ROMDAS Approach

The user does not need to survey the other side of the road immediately. By opening an existing file the operator will be prompted if they want to continue an existing survey or survey the other side. This makes it possible to plan the surveys in the most efficient manner possible.

NOTE: This option cannot be used in conjunction with LRP resets. In such a case there should be separate files of LRPs for each lane. It will also not work if you are manually defining the end of the roughness sampling interval.

WHAT CAN YOU RECORD IN THE DIFFERENT TYPES OF SURVEYS

Roughness Survey: You can record (1) the roughness; (2) keyboard events; (3) new location reference points; (4) the transverse profile; (5) GPS data; (6) skid resistance; (7) traffic counts.

Travel Time and Congestion Survey: You can record (1) speed; (2) keyboard events; (3) new location reference points; (4) GPS data; (5) skid resistance; (6) traffic counts.

Keyboard Rating Survey: You can record (1) keyboard events; (2) new location reference points; (3) the transverse profile; (4) GPS data; (5) skid resistance; (6) traffic counts.

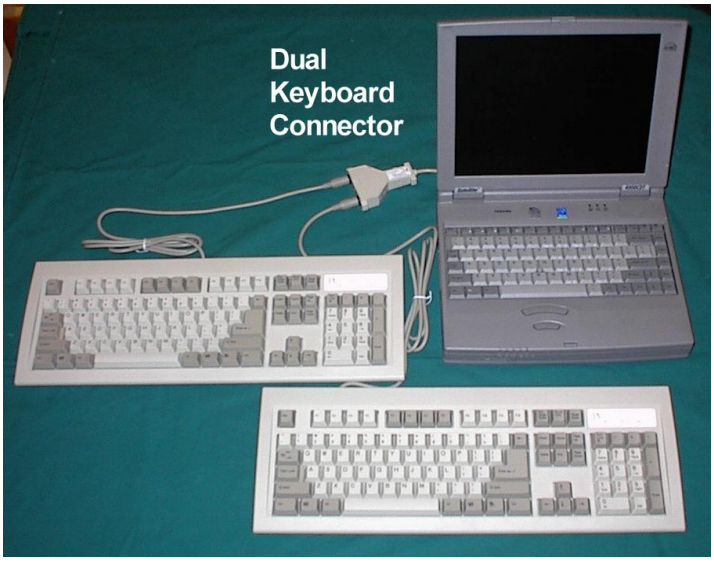
Location Reference Point Survey: You can record (1) location reference points; (2) keyboard events; (3) the transverse profile; (4) GPS data; (5) skid resistance; (6) traffic counts.

© 2001Data Collections Ltd..

Box 2.1 Multiple Keyboards

Many notebook computers will support an external keyboard being operated at the same time as the internal keyboard. This makes it possible to have an observer in the front seat of a vehicle recording distresses while a second operator is in the rear of the vehicle operating the ROMDAS equipment and doing and LRP survey. The advantage of this approach is that it reduces the demands on the ROMDAS operator and should thereby improve the quality of the distress ratings.

DCL can supply a special keyboard adapter which will allow most notebook computers to run 2 external keyboards (or two of our 20 key rating keyboards) as well as the internal keyboard. This makes it possible to assign different tasks to the individual raters—for example condition and inventory surveys. The photograph below shows the system with a Toshiba notebook.



© 2001Data Collections Ltd..

3. INSTALLATION OF ROMDAS IN VEHICLE

3.1 INTRODUCTION

Figure 1.1 illustrated the ROMDAS system. Before installing ROMDAS, please read the warranty details in Chapter 20. If these are unacceptable return the uninstalled unit. Your payment will be refunded less shipping charges. ANNEX B contains a list of parts that should have been supplied with ROMDAS. It also lists the recommended spares and accessories. ANNEX C gives a schematic diagram of the various ROMDAS connections and ANNEX D the wiring connections.

The installation procedure consists of installing the ROMDAS hardware in the vehicle and making the necessary electrical connections. The typical connections for the ROMDAS equipment are illustrated in Figure 3.1 and Figure 3.2 with the schematic diagrams in ANNEX C giving fuller details.

All systems consist of:

- ROMDAS hardware interface
- speedometer sensor
- on/off power switch
- notebook computer

Optionally, there can also be:

- Bump Integrator(s) for recording roughness
- Single camera video system
- Multiple camera video system
- Transverse Profile Logger (TPL) for recording transverse profile and rut depths
- Gyroscope system
- GPS receiver
- GripTester for skid resistance
- Digital camera for photographing roadside elements
- Tape recorder for making voice notes

3.2 INSTALLING ROMDAS HARDWARE INTERFACE

The hardware interface of ROMDAS is very small and portable, however, it can be installed permanently into a vehicle. The unit can be positioned anywhere in the vehicle, however, the following is recommended:

- It should not be on the floor as it may be stepped on. If it must be on the floor it should be placed in a protective enclosure with holes cut to allow access to the wires.
- The lights should be visible to the operator so that they can observe if there is a loss of power or signal from the distance sensor or roughness meter.

© 2001Data Collections Ltd..

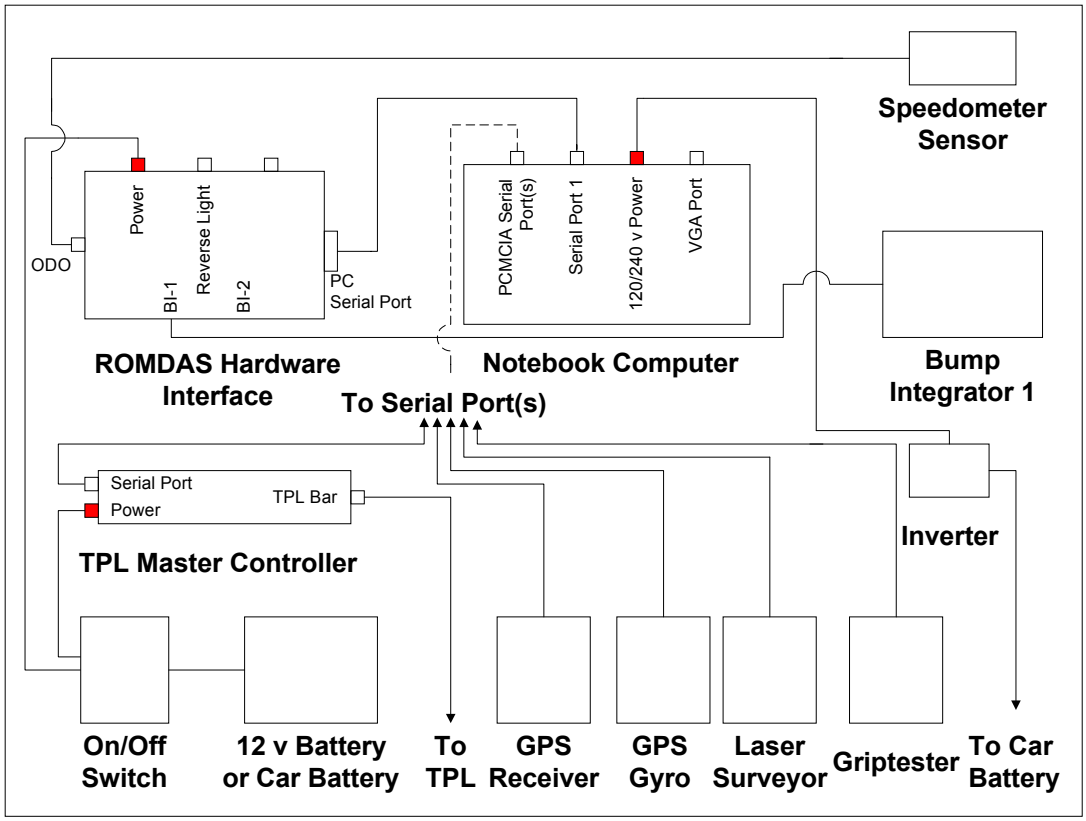


Figure 3.1: ROMDAS Connections

The most complicated component of installing the hardware interface is the connection to the distance measurement sensor. The following sensors are available for ROMDAS:

- Speedometer Cable – Gearbox Connection Sensor
- Speedometer Cable – Inline Spliced Sensor
- Electronic Speedometer Sensor
- Proximity Sensor
- ROMDAS High Resolution DMI
- ROMDAS 5th Wheel DMI

The first three are the 'standard' ROMDAS sensors and work with most vehicles. The proximity sensor is used on vehicles with electronic speedometers that have pulses too low to be measured with the standard electronic sensor. This problem has only been reported with a Nissan utility vehicle. The ROMDAS high resolution DMI is recommended for applications where very high resolutions are required—such as acceleration behaviour monitoring. Due to the potential for mis-installation damaging the unit, this unit has a 30 day warranty period. The ROMDAS 5th wheel is similar to the DMI, but it is attached to the side of the vehicle via a suction attachment and can be readily removed.

With speedometer cables, the gearbox connection sensor works on most modern Japanese vehicles. As shown in ANNEX E, it is connected between the gearbox and the cable. It is very quick to install compared to the splice in sensor which requires that the speedometer cable be disconnected from the gearbox and the speedometer and have the inner cable removed before splicing in (see ANNEX E).

© 2001Data Collections Ltd..

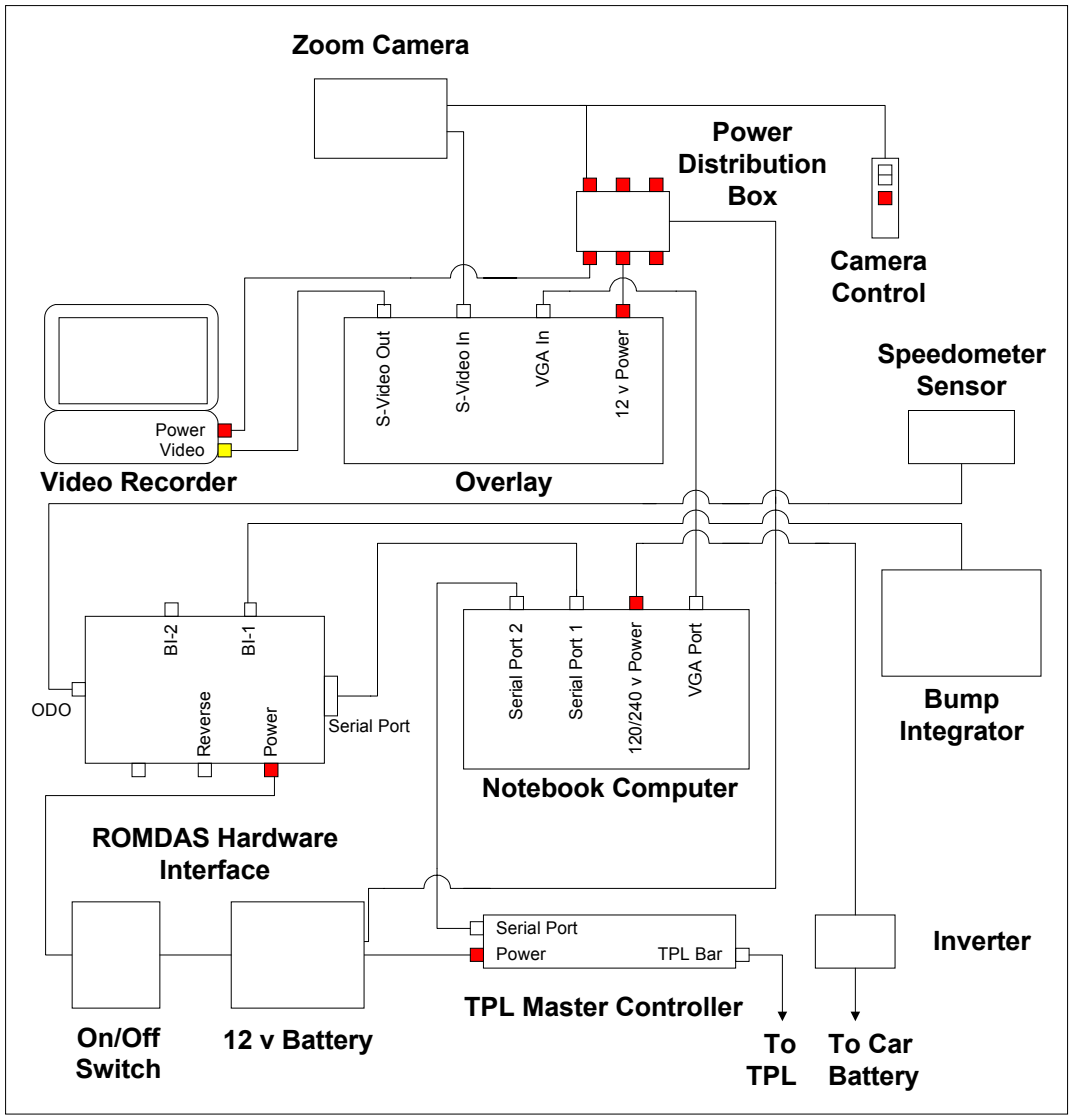


Figure 3.2: ROMDAS Connections – Single Video Camera

It should be appreciated that ROMDAS is very 'forgiving' when it comes to the type of distance measurement device that can be used. Any type of sensor that will send a clean 5 v pulse will work with ROMDAS.

Irrespective of what type of sensor is installed, the wires should be run from the sensor to the ROMDAS hardware interface avoiding all high tension wires *etc*. It is common to route the lines through the wall between the dashboard and the engine compartment where there are often existing access points.

3.3 HARDWARE INTERFACE CONNECTIONS

There are four different versions of the hardware: referred to as the v 2, v 3 and v 4 interfaces:

- The v 5 interface, released in late 1999, has two circular DIN sockets on the side for two bump integrators, a third DIN socket on the end for the odometer connection, and three bayonet sockets on the side for power, reverse light and auxiliary connections.
- The v 4 interface is identical to v 3 with the only difference being the code in the ROMDAS EPROM.

© 2001Data Collections Ltd..

- The v 3 interface was introduced in 1996 and has a 9-pin RS-232 port, 2 circular DIN sockets, and 2 bayonet plug sockets.
- The v 2 has a 25-pin RS-232 and a 9-pin RS-232 ports.

The 9-pin RS-232 plug on both interfaces is used to connect the interface to the computer. This is a straight through connection and a standard extension cable may be used. A 'Null Modem' cable, which has pins 2-3 and 3-2 connected will not work.

NOTE: When installing the various ROMDAS cables ensure that they are kept a good distance from any of the vehicle high voltage lines (e.g. spark plug wires). If this is not done, an electrical charge may be transmitted to the ROMDAS damaging the unit and voiding the warranty.

Version 5 Interface

The v 5 interface has the RS-232 connection at one end and a socket on the other end of the unit for power. The connections to the sensors is made through a series of sockets on the sides of the unit.

- Din socket for roughness meter one (BI 1);
- Din socket for roughness meter two (BI 2);
- Din socket for distance/speed sensor (ODO);
- 1 pin bayonet socket for power plug;
- 1 pin bayonet socket for reverse light plug; and,
- 1 pin bayonet socket for auxiliary instruments.

Next to each connection is an LED which serve the following functions:

- **RS-232 LED** (Yellow or Green) - indicates that the software is communicating with the hardware by flashing approximately once per second;
- **Power LED** (Red) - indicates that the system is receiving power correctly;
- **Odometer LED** (Yellow) - flashes each time an input pulse is received from the odometer sensor;
- **Roughness Meter LEDs** (Yellow) - flash each time an input pulse is received from the roughnesss meter;
- **Reverse Light LED** (Green) - lit when 12 volts are applied to the reverse switch input.

ANNEX D gives the pin assignments for the plugs.

Version 3/4 Interface

The v 3/4 interface has the RS-232 connection at one end and a socket on the other end of the unit for power. The connections to the sensors is made through a series of sockets on the side of the unit and consist of:

- DIN socket for roughness meter;
- DIN socket for distance/speed sensor;
- 1 pin bayonet plug socket for reverse light sensor.

ANNEX D gives the pin assignments for the plugs.
Adjacent to each socket is a series of LEDs. These serve the same functions as with the v 5 interface.

© 2001Data Collections Ltd..

Version 2 Interface

The 25-pin plug on the v 2 interface contains connections for the following:

- power supply;
- roughness meter sensor;
- distance/speed sensor.

ANNEX D describes the pin assignments.

3.4 POWER CONNECTIONS

Power is supplied to the ROMDAS Hardware Interface via the socket on the side of the box labelled 'power'. There are two power units available for ROMDAS, the standard unit which is shipped with all systems, and the 'Power Distribution Box' which is shipped with systems using multiple instruments or the video system.

All power plugs and sockets have screw connectors to ensure a good connection.

Standard Power Switch

The power is provided through a remote switch which consists of a plastic box with an on/off switch, an LED and a 0.5-1.0 amp fuse. Figure 3.3 illustrates the ROMDAS Power Switch.

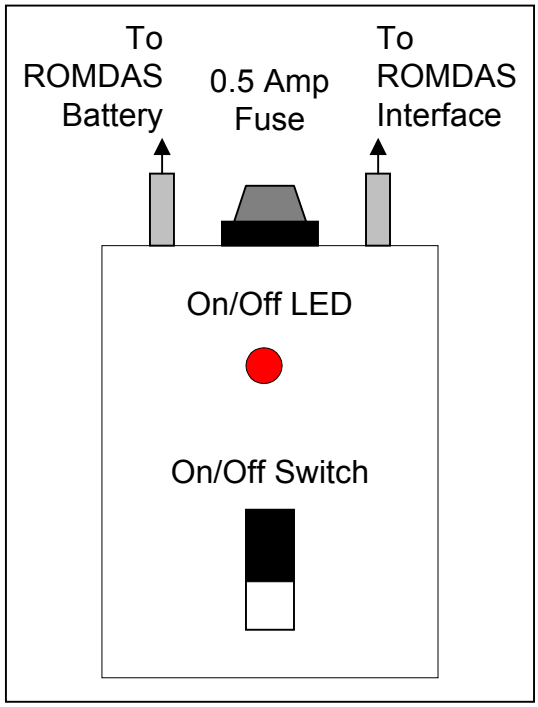


Figure 3.3: ROMDAS Power Switch

The ROMDAS Power Switch has two cables:

- cable with bare wires - to battery;
- cable with bayonet plug - to ROMDAS. This cable has a red sleeve on it, corresponding to the red marker next to the power socket.

It there is a TPL, a third cable which is a TPL output is included.

© 2001Data Collections Ltd..

The connections are:

Connections:	BROWN	Positive (+)	CENTRE PIN
	BLUE or WHITE	Negative/Earth (-)	OUTER PIN

Power Distribution Box

The power distribution box is provided when there is a video system, or multiple instruments are used (such as a GPS, gyro, laser surveyor). The unit consists of six sockets and four cigarette lighter adapters. It connects directly to the battery and also provides connections for the inverter.

Most damages to ROMDAS are caused by the host vehicle's electrical system not being up to standard—*i.e.* putting through excessive currents to the system. If there is any doubt whatsoever about the quality of the system, it is recommended that ROMDAS be powered by its own 12 volt D.C. battery. The ROMDAS battery should be connected to the ROMDAS power switch during surveys. The battery will need to be recharged and it is recommended that this be done by removing it each night and using a standard commercial battery recharger or simply swapping each day with the car's battery so it is recharged while driving.

The ROMDAS interface draws approximately 0.1 Amps including power for the odometer and roughness meter so typical automotive/motorcycle batteries will usually last for several weeks worth of surveys, although this is significantly reduced if the video and TPL are used.

By using its own battery the system is isolated from most irregularities in the vehicle power supply. The only likely source of a voltage spike with be through the PC serial connection which unfortunately cannot be completely isolated.

NOTE: For **most** modern vehicles you can run the standard ROMDAS power switch from the cigarette lighter. The power distribution box connects directly to the car's battery.

DO NOT turn ROMDAS on until after the vehicle has been started as power surges through the computer may damage the unit. Although ROMDAS contains power regulating circuits, damages caused by improper installation or poor vehicle electrical systems are expressly excluded from warranty claims. Please ensure the quality of the electrical system before installing the system to the vehicle.

3.5 BUMP INTEGRATOR CONNECTIONS

ROMDAS is designed to work with either the electrical or mechanical versions of the Bump Integrator (BI). The underlying principle behind either is the same. It has also been designed to accommodate most other RTRRM systems. ANNEX F contains installation instructions for the ROMDAS BI and the TRL BI.

As shown in Figure 3.4, ROMDAS can be used with one or two BI units. The most common configuration is with a single BI connected to the middle of a solid axle. This gives a 'half-car' roughness index as it records the response of both wheels. If the vehicle has an independent rear suspension one or two BI units can be used, each giving a 'quarter-car'

© 2001Data Collections Ltd..

roughness count. It is preferable to use two BI units in this case in order to accurately measure the roughness of both wheelpaths. Improved roughness measurements will arise when using two roughness meters instead of one on vehicles with a solid rear axle.

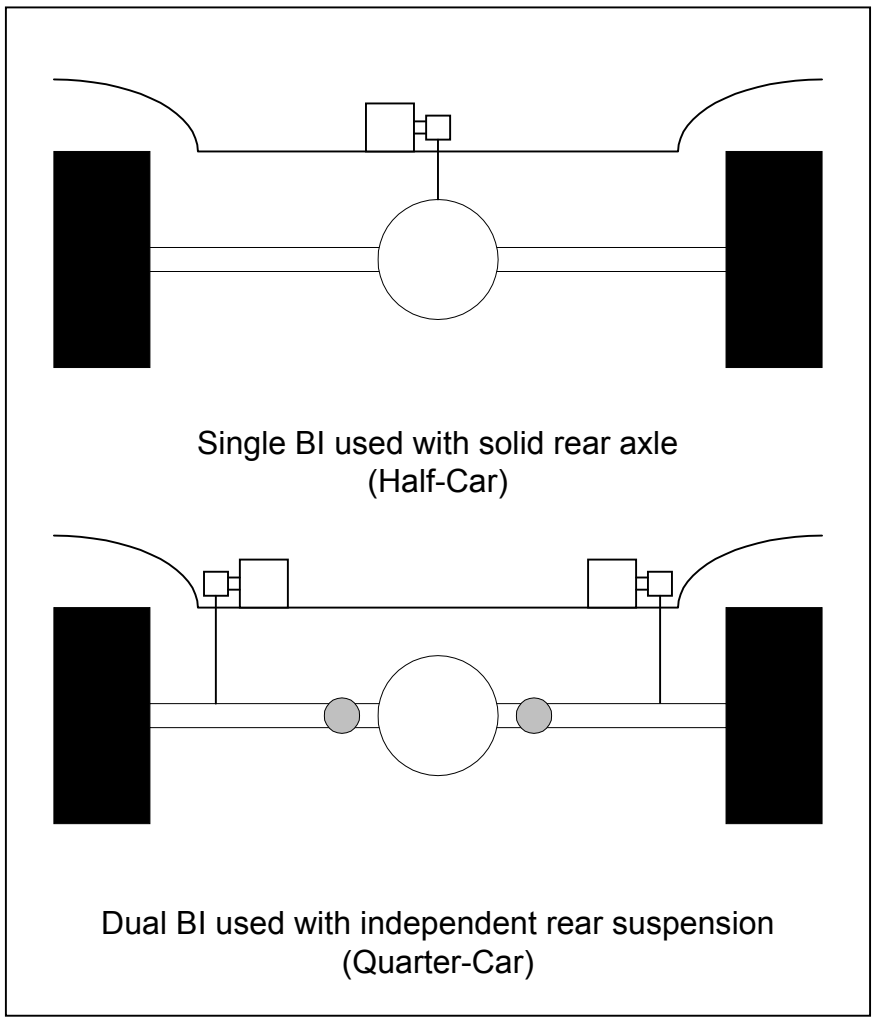


Figure 3.4: Half or Quarter-Car Roughness Meter Installations

The BI is installed to the BI 1 socket on the v 5 interface and, if two BI are installed (quarter-car), the second is installed to the BI 2 socket. With the v 3 or 4 interface it is connected to the centre DIN socket on the side of the interface.

Full installation instructions for the BI are given in ANNEX F.

All systems must use a 5 volt D.C. supply. It must be stressed that considerable care must be taken when installing any instrumentation that has not been provided by DCL to the hardware interface. The connections are:

ROMDAS BI		
	RED	Positive (+) 5 volt supply
	BLACK	Earth
	GREEN	Signal from sensor
Farnell TRL BI		
	RED	Positive (+) 5 volt supply
	BLACK	Earth
	GREEN	Signal from sensor

© 2001Data Collections Ltd..

3.6 DISTANCE AND SPEED SENSOR CONNECTIONS

The sensor is supplied with its own cable. The DIN connector plugs directly into the end socket on hardware interface. The manufacturer's installation instructions for the sensor are given in ANNEX E.

3.7 REVERSE OPTION

ROMDAS can optionally be connected to the reversing light of the vehicle (to the earth side which leads to the reversing light switch). With the v 3/4 hardware there is a dedicated bayonet plug socket (centre pin +) to the left of the DIN plugs. The reverse light cable has a yellow shroud which corresponds to the yellow mark next to the reverse light socket.

When ROMDAS is being used as a digital distance/speed this line tells the system to decrease rather than increase when reversing.

NOTE: It is recommended that the 'Reverse Option' **NOT** be used unless it is absolutely essential. This is because fluctuations in the vehicle power levels could damage the ROMDAS unit. If this option is to be used the ROMDAS must be installed by a qualified auto electrician and checks must be made that excessive charges are not being passed to the unit.

3.8 TRANSVERSE PROFILE LOGGER

The transverse profile logger (TPL) must be mechanically installed in the front of the vehicle and power supplied to it. It is then connected directly to the computer via a second serial port on the computer. ANNEX G gives detailed installation instructions for the TPL.

3.9 VIDEO SYSTEM

The ROMDAS Video System (VS) superimposes key data onto a video or camcorder. This includes the route name, chainage and vehicle speed as well as roughness and keycode events.

Figure 3.5 shows the components of the VS. ANNEX H describes the installation of the system in the vehicle and how it is set up. The system may be used with more than one camera, with each camera recording to their own VCR.

In order to use the system it is necessary that the computer allow for the simultaneous display of information on the internal screen and an external monitor. Most notebook computers have this facility. The character overlay device is plugged into the external monitor port on the computer and the camera is then connected to the overlay device.

NOTE: The character overlay device superimposes the entire screen on the video. In order to be used it is necessary to implement the 'Reduced Screen' display option. This is accessed via a password through the **SETUP|OPTIONS|VIDEO** menu (see Section 5.6.3). This password is only available to those who have paid the access fee to DCL.

© 2001Data Collections Ltd..

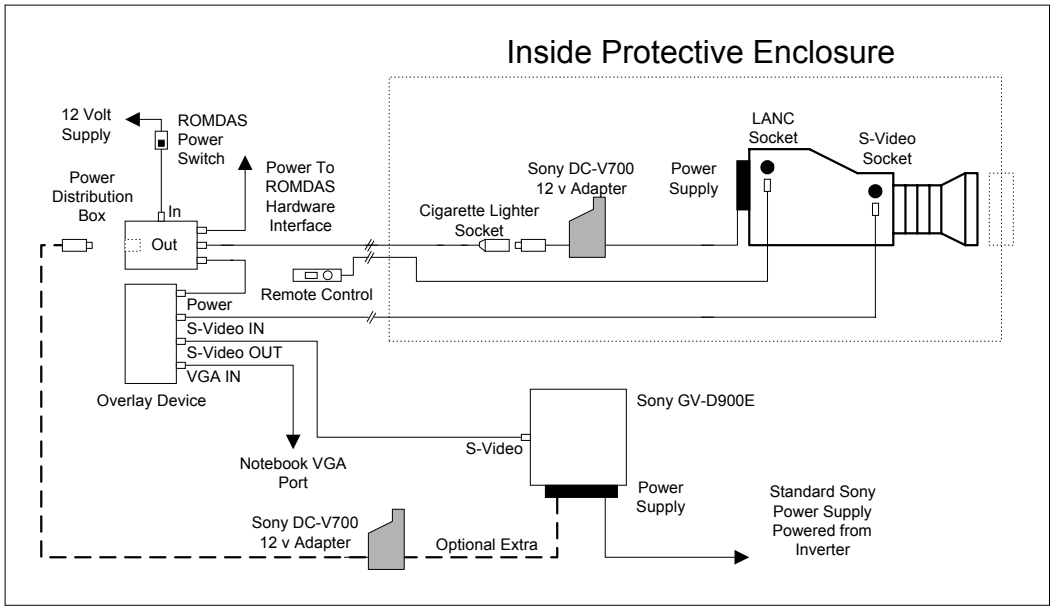


Figure 3.5: ROMDAS Video System

Box 3.1 Potential Incompatibilities for Video System

The ROMDAS Video System is designed to work with notebooks that allow for a simultaneous display of information on the notebook screen and an external monitor. Most notebooks have this feature. There are several potential incompatibilities:

- The display should also allow for CGA mode to display the large characters and have the display covering the full screen area ('stretched or enhanced' display).
- Some systems do not display the text over the full area of the screen when running in MS-DOS mode.
- Some systems have a non-standard refresh rate which causes the overlay to flicker.
- Notebooks have proprietary graphics cards and these are not always compatible with the overlay device that is used in the ROMDAS Video System. The problem has been noted only with a Toshiba 2110 CS, but may arise with others. Under these conditions the system will overlay information on the screen only when the notebook screen is turned off.

A list of computers tested by DCL or reported by users to work with ROMDAS is given in ANNEX P (page 264).

3.10 CALIBRATION PROXIMITY SENSOR

A 'proximity sensor' can be used to start/stop the recording during a calibration exercise. This is done by connecting the sensor it to the reverse switch in the hardware interface in such a way that it provides a change in 12 v state when triggered.

ANNEX I describes the fabrication of a simple proximity sensor.

© 2001Data Collections Ltd..

3.11 USING ROMDAS IN MORE THAN ONE VEHICLE

To use ROMDAS in more than one vehicle it will be necessary to obtain additional speedometer sensors and, optionally, power on/off switches. In some situations it may be preferable to use the high resolution DMI or even a fifth-wheel instead of the in-vehicle odometer. These allow for the unit to be quickly mounted to any vehicle.

For those using the v 2 hardware interface it is recommended that an additional wiring harness be obtained. These accessories are available from DCL.

3.12 IF SOMETHING GOES WRONG

ANNEX O contains instructions to assist with problem solving.

The first thing to do is **CHECK THE FUSE**. With few exceptions, these have been the causes of ROMDAS failures. The fuse is located in the side of the power switch housing. If it is not the fuse do the following:

1. Ensure that there are no programs drivers loaded into the computer AUTOEXEC.BAT or CONFIG.SYS files.
2. Check that the red light on the power switch is on and that the red light on the hardware interface is on. If the red light on the power switch is not on, take the multimeter supplied with ROMDAS and check that there is not a broken wire. This is the cause of the problem. If there is power to the system the problem is either with the interface or the PC.
3. Turn the power OFF and then ON to reset the unit.

If the system is still not working plug connect the hardware tester (see Figure 3.6) and use one of the ROMDAS diagnostics programs. The version to use depends upon if you have a v 4 or later interface.

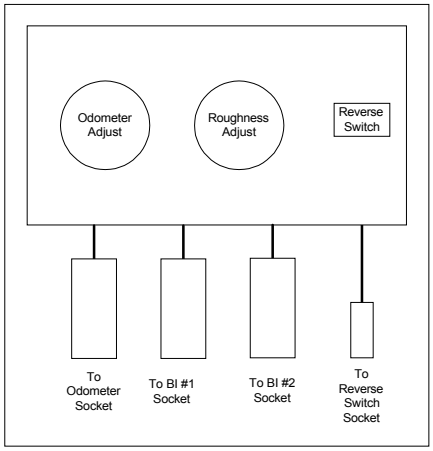
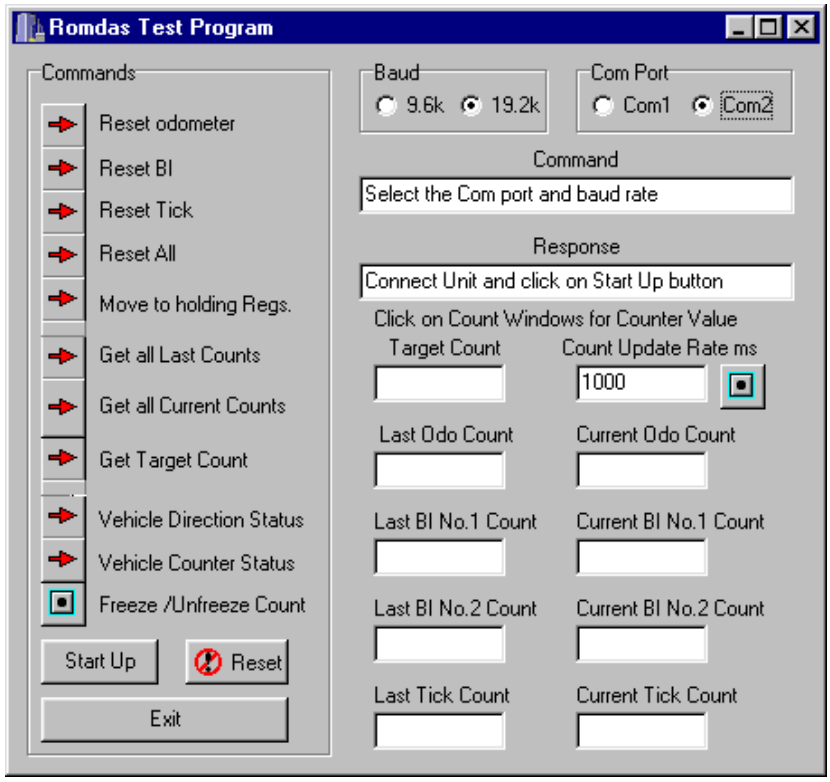


Figure 3.6: ROMDAS Tester

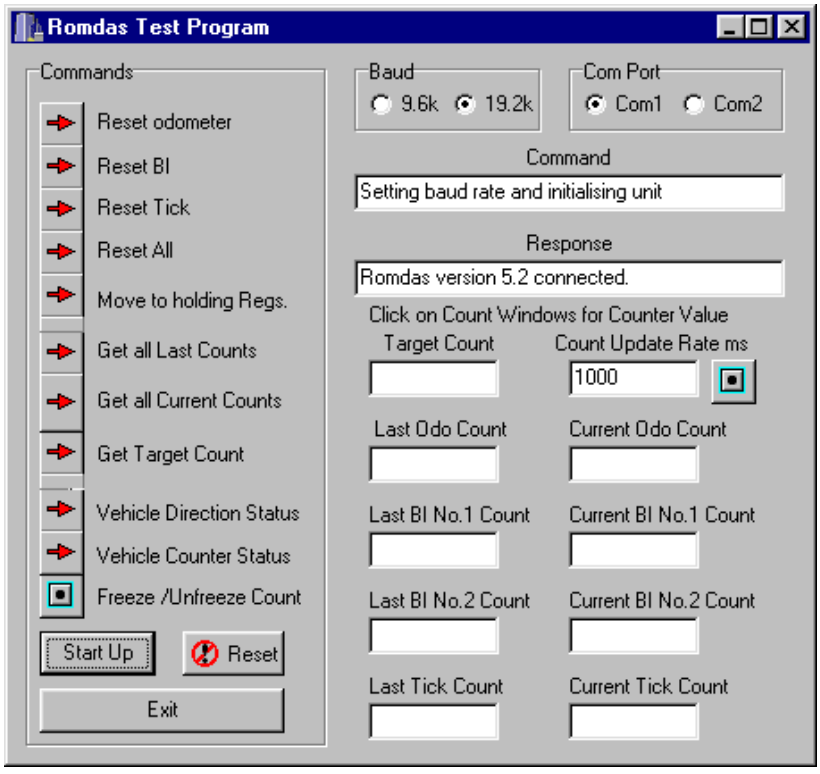
Version 4 or 5 Interface

- Insert the 'ROMDAS CD' to the CD drive
- From Windows Explorer select the folder **Software|floppy** and extract the files from Rdaststst.zip to the user folder.
- Double click the Rda5tst.exe. You will be given the following opening screen:

© 2001Data Collections Ltd..

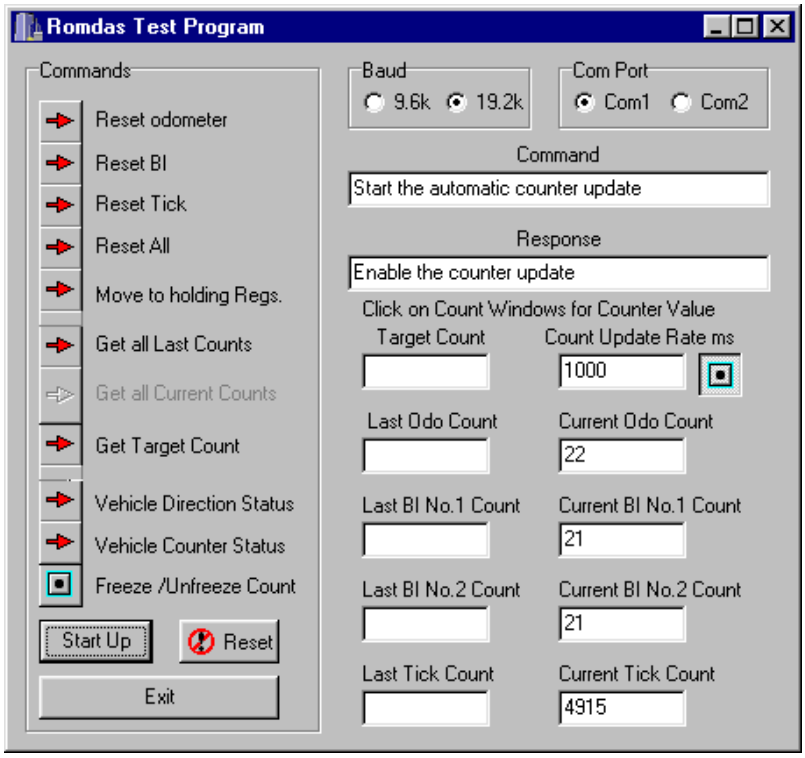


- Select **19.2k** for **Baud** and appropriate Comport.
- Have the ROMDAS System ready connected to Tester and click **Start UP** button.
- If you have ROMDAS system connected properly with the interface and tester the following screen will appear:



- Select **1000** for **Count Update Rate ms** to continue. Click the **button** given below **Count Update Rate ms** to read the data from interface.

© 2001Data Collections Ltd..



- Click the **arrow** provided to **Reset BI** to reset the BI count. Click other Reset buttons to make sure the interface responding properly.
- Click the **Get Target Count** and enter a value of **1000**. Note that all the data resets at 1000 **Odo Count** as given for the **Target Count** and transfers the data as old counts.
- Click the **Vehicle Direction Status**, **Vehicle Counter Status** to check the direction (forward direction) and counter status (low).
- Click the Freeze/Unfreeze button to freeze and unfreeze the button.
- Click **Exit** to exit the testing.

Version 3 Interface

1. Run the program RDASTEST. This is done by changing to the directory with the program (usually CD\RDASTEST) and typing the command RDASTEST at the DOS command line and pressing ENTER. The program will perform a diagnostics check on the interface. This will identify any problems with the interface. Figure 3.7 is an example of the display when there is a successful run of RDASTEST. **NOTE:** The colours of the LEDS may be different.
2. If the RDASTEST program does not identify any problems, run the ROMDAS program from the computer. Start a roughness survey with the tester connected to the interface. By adjusting the dials the speed and roughness counts should change.

If there are still problems please contact DCL for support.

© 2001Data Collections Ltd..

```
                    ROMDAS 3 Test Program

Is th ROMDAS unit connected with the LED by the serial cable flashing at 2 Hz? (Y/N) >
What is the COM port number the unit is connected to? < 1 to 4> 1

Now in ROMDAS test mode.
Use the ESC key to exit

Test No 1:
Checking the reverse input.
Press the reverse button on the test unit and note response.
When completed hit any key or ESC to exit.
Reverse LED off and input at 0 volts.

Test No. 2:
Checking the odometer and bump integrator sensor inputs.
>All unit counters unfrozen and ready to accept input pulses.
Check that odometer and bump integrator input LED's are on or flashing.
Hit any key to continue or ESC to exit.
>All unit counters cleared.
Wait for about 10 seconds while the input pulses are counted ...
>All unit counters now frozen
>306 odometer counts were recorded.
>358 bump integrator counts were recorded.
>0006 tick counts of 1.25 ms were recorded.
Do you want to run this test again? <Y/N>  N

Status report on ROMDAS unit under test.
Unit is connected to COM1 at 9600 baud.
Reverse input.          GOOD
Odometer input.         GOOD
Bump input.             GOOD
Unit Tick Counter.      GOOD
```

Figure 3.7: Example of Successful RDASTEST Test Run – v 3 Interface

© 2001Data Collections Ltd..

4. INSTALLING AND STARTING THE ROMDAS SOFTWARE

4.1 INTRODUCTION

ROMDAS is the software which runs the ROMDAS system. It is designed to operate on an IBM compatible PC running MS-DOS. With the release of the v 4 software, there is a single release which works on all the hardware interfaces (v 2, v 3 and v 4 interfaces). There are three survey options depending upon which version of the software was purchased:

- Roughness
- Travel Time
- Roughness and Travel Time

At the time of purchase you will be provided with a password to access the appropriate survey option. After purchase it is possible to upgrade upon payment of the appropriate fee to DCL.

All systems include Location Reference Point and Keycode Rating surveys as well as the Odometer system. They also support video, GPS, transverse profile and skid resistance surveys, although these are accessed via password protected menus.

Programmed in Clipper and C, ROMDAS runs via a series of menus. These menus are used to input various details for the survey. There are also system utilities and access settings which are accessed by a password.

4.2 THE ROMDAS SOFTWARE

The ROMDAS system comes with the following:

- 3.5" floppy disk with ROMDAS executable program
- CD ROM with ROMDAS supporting materials
- Form confirming the version number supplied and the passwords

The 3.5" floppy disk always contains the most recent version of the ROMDAS software, although the ROMDAS web site at www.ROMDAS.com should be checked for an even more up to date version.

The CD contains an assortment of supporting materials, photos of ROMDAS vehicles, and software for ROMDAS. For example, it includes this manual as an Acrobat .PDF file as well as the Acrobat Reader which allows the file to be printed. There is an introductory video to ROMDAS which should be viewed to get an overview of the system and how it is installed to a vehicle. The various files are accessed from a menu.

It should be noted that the CD may not be readable on older computers due to it being created on a HP CD Writer.. If problems are found you should test it on a different, preferably newer, computer.

4.3 INSTALLING THE PROGRAM

Although it is a DOS program, most users run ROMDAS under Windows 95. It is important that there is a completely 'clean' system otherwise conflicts may arise and data may be lost or corrupted. The CONFIG.SYS file should **ONLY** have in it the following commands:

```
files=40
buffers=20
```


© 2001Data Collections Ltd..

```
dos=high,umb
device=c:\windows\himem.sys
device=c:\windows\emm386.exe ram [if not using Windows 95]
device=c:\windows\emm386.exe noems [if using Windows 95]
```

If you are not using Windows 95 but MS-DOS—for example due to the age of the computer or the need to access PCMCIA cards not supported by Windows 95—the emm386.exe program has the RAM switch after it.. This is done since ROMDAS makes use of expanded as opposed to extended memory. When running under Windows 95 the noems switch is used since Windows manages the computer's memory. For those users who need to boot to DOS under Windows 95 ANNEX S (page 274) explains how to make a boot menu which will allow you to select different start options.

In the AUTOEXEC.BAT there should be **ABSOLUTELY NO** programs loaded into memory, only a path statement and any commands preceded by the word "SET". If you must load a program, use the loadhigh command before the program name (*e.g.* lh c:\windows\command\doskey.com). This will load the program into high memory.

See ANNEX P (page 264) for other commands which may be necessary to include when solving memory problems.

Box 4.1 Conflicts

We cannot over emphasise the importance of having no drivers or programs loaded in you CONFIG.SYS and AUTOEXEC.BAT files. These are the cause of almost all problems that users have when first using ROMDAS. If ROMDAS does not work be sure to check these files first. Failing this, see ANNEX P (page 264) for computer compatibility issues before going into the problem solving described in Section 3.12.

To install the program, insert the ROMDAS floppy disk supplied into the floppy drive, log onto the drive (usually A:) and type:

```
SETUP          (Press ENTER)
```

You will then be prompted which directory to extract the ROMDAS software to (default=c:\ROMDAS). If you want to access the software from Windows you can create a shortcut as explained in ANNEX U.

The ROMDAS disk contains some important supplementary programs. These are accessed by typing

```
GO             (Press ENTER)
```

You will be presented with a menu. Press the F1 key to obtain the current information about installing the program.

The installation process is initiated by pressing the F2 key. You will be given a list of the programs that can be installed. This will contain the following names:

RDASTEST	Test program for ROMDAS Hardware Interface
NLREG34	Non-linear Regression Package
IRICALC	Programs for calculating IRI from road profiles[1]

[1] See ANNEX J for a discussion of these programs.

© 2001Data Collections Ltd..

Pressing the function key installs the program.

The ROMDAS CD contains the manual in an Adobe Acrobat 4 file[1] as well as a number of additional applications and documents.

You select the program to be installed by pressing the F1 or the F2 key. The installation routine then lists the directory which the program will be installed to on your hard disk. This defaults to the C: drive and the names of the programs as given above. Press ENTER to accept this name or else supply a new name. The program will then install the software to the appropriate subdirectory. It is recommended that you maintain the version number in the subdirectory names so as to differentiate between upgrades and previous versions.

At the completion of the installation process the file README.TXT will be displayed. This contains current information on the programs so please read it by scrolling through by pressing any key.

After the installation of the ROMDAS software the following files should be present in the ROMDAS subdirectory:

ROMDAS.EXE	Executable ROMDAS program
ROMDAS.CFG	ROMDAS configuration file
READ.ME	Text file with late breaking news on ROMDAS
SURVEY.BAT	Batch file for running software for a survey
TEST.BAT	Batch file for running software in test model

After you have set up the software there may be the following additional files (see Chapter 5).

KEYCODE.DBF	ROMDAS keycode event file
LRP_DEF	LRP Definition File
MSGENGL.DBF	ROMDAS menu titles in the English language
MSGSPAN.DBF	ROMDAS menu titles in the Spanish language
MSGLOCAL.DBF	ROMDAS menu titles in the local language (user defined)

4.4 DIRECTORY STRUCTURE

The ROMDAS files are stored in a series of subdirectories under the user-defined main directory. The main directory is usually where the basic ROMDAS files reside: ROMDAS.EXE, ROMDAS.CFG, KEYCODE.DBF, LRP_DEF.DBF, MSGENGL.DBF, and MSGLOCAL.DBF. However, as described in Section 5.5, it is possible to assign the main directory to any directory on the hard drive.

A series of subdirectories are created for each type of survey or activity than is performed with ROMDAS, specifically:

- **ROUGHNESS SURVEY**: Data collected in road roughness surveys;
- **LOCATION REFERENCE POINT SURVEY**: Data on location reference points;
- **KEYCODE SURVEY**: Data from keyboard rating of events;
- **TRAVEL TIME SURVEY**: Data from travel time and congestion surveys;
- **TRANSVERSE PROFILE SURVEY**: Data on the pavement transverse profile;

[1] The manual is provided to allow you to print additional copies of the manual. Please note that registered users are permitted to print additional copies for personal use only (see page 2 of this User's Guide for copyright information). If you do not have Adobe Acrobat you can download a Viewer/Printer program from the Internet at www.adobe.com. It is also included on the ROMDAS CD.

© 2001Data Collections Ltd..

- **GPS SURVEY**: Data from a GPS survey;
- **SKID RESISTANCE**: Data from skid resistance surveys;
- **TRAFFIC**: Data from moving traffic surveys;
- **LONGITUDINAL PROFILE**: Elevation profile data for calculating IRI;
- **SURVEY LOGS**: Logs summarising the surveys and the chainages of events;
- **CALIBRATION**: Calibration files for the BI and TPL.

Under each of these subdirectories are up to three further subdirectories:

- **RAW**: Raw data collected in a survey;
- **PROCESSD**: Processed raw survey data;
- **EXPORT**: Text files created from the survey or processed data.

The processed data subdirectory is only used with the roughness, speed, transverse and longitudinal profile data.

Figure 4.1 illustrates the ROMDAS directory structure and the file locations.

4.5 TEST MODE/SURVEY MODE

The ROMDAS software has two modes:

- "Test Mode" which allows the user to become familiar with the features and operation of the software in an office environment;
- "Survey Mode" which is used for an actual field survey.

The test mode should be run to evaluate the software before the system is installed in a vehicle.

These are initiated by changing to the ROMDAS directory and typing in the command:

SURVEY	(Press ENTER)	Survey Mode
TEST	(Press ENTER)	Test Mode

A batch file is run which executes the program. In "Test Mode" the program is run with the flag /T (i.e. ROMDAS /T).

NOTE: Unless you are in test mode, attempting to run the ROMDAS without the computer being attached to the hardware will result in a communications error and will probably lock up the computer.

© 2001Data Collections Ltd..

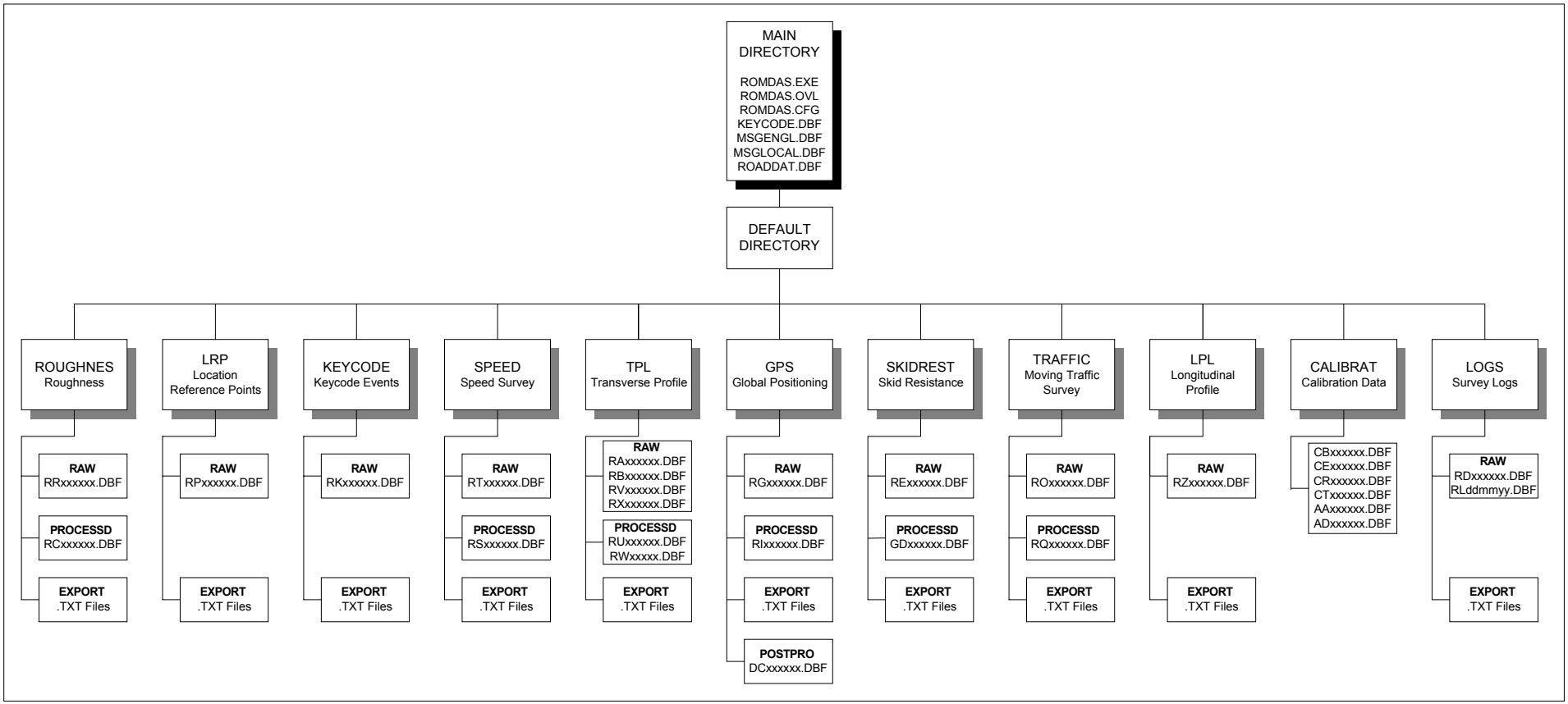


Figure 4.1: ROMDAS Directory Structure and Contents

© 2001Data Collections Ltd..

Box 4.2 When to Use Test Mode or Survey Mode

When do you use which?

- If you do not have a ROMDAS hardware interface connected to the computer use **Test Mode**.
- If you have a ROMDAS hardware interface connected to the computer and are using either the ROMDAS tester or testing it in the vehicle use **Survey Mode.**

The difference is this: in test mode ROMDAS generates all the pulses internally. That is why you will see a constant speed and number of roughness counts. In survey mode the hardware interface sends the pulses to the unit as they are generated either by the tester or the vehicle.

4.6 SERIAL NUMBERS

Each ROMDAS program has its own unique serial number and this is written on the 3.5" floppy disk. As of version 2.1 these are no longer associated with a single hardware interface. Please be sure to return the ROMDAS registration form (Appendix A) with your serial number so that you will receive bug fixes of the software. If you have access to e-mail please ensure that you provide your address so that you will automatically be sent minor upgrades/bug fixes electronically.

If you are sent an update without a serial number you can enter your own serial number by typing in the command:

ROMDAS /NEWSERIAL

Enter your serial number which is on the hardware interface or the old version of the program into the box provided.

4.7 THE FIRST TIME

Before conducting a survey, it is necessary to become familiar with the ROMDAS software. ANNEX N contains a set of 'Step-by-Step' instructions for setting up and operating the software.

When ROMDAS is run, the opening menu lists the options available to the user. It is illustrated in Figure 4.2. The actions of each option are:

ROAD ROUGHNESS SURVEY	Conduct a roughness survey
TRAVEL TIME AND CONGESTION SURVEY	Travel time and congestion survey
KEYBOARD RATING SURVEY	Record locations of events
LOCATION REFERENCE POINT SURVEY	Survey location reference points
ODOMETER SYSTEM	Use the PC as a digital odometer
DATA MANAGEMENT	View and manipulate data files
SETUP	Set up system parameters
INFORMATION	Version number, disk space, etc.

© 2001Data Collections Ltd.

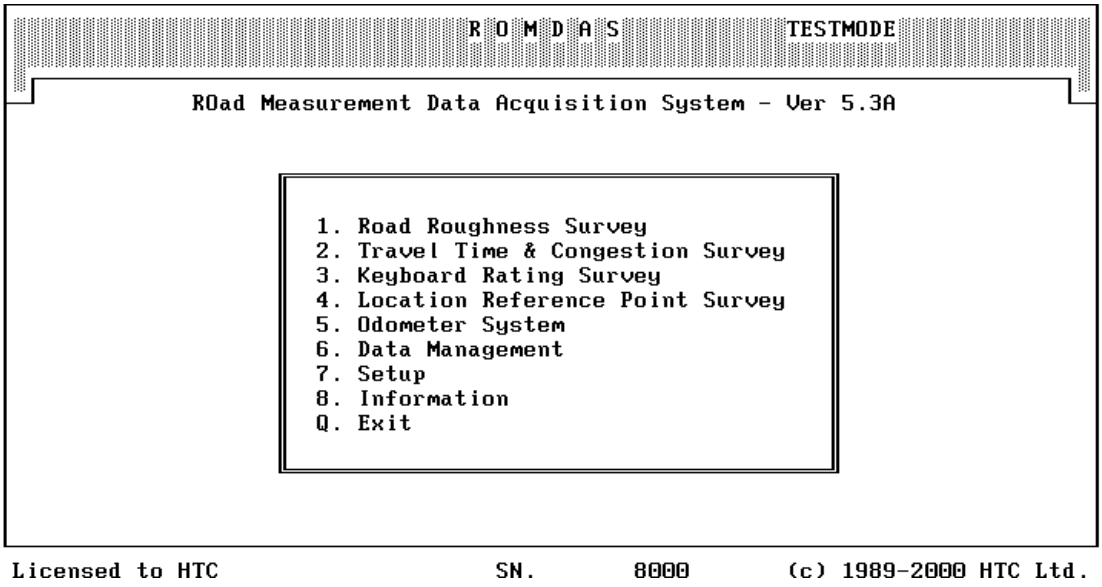


Figure 4.2: Opening Menu

The user selects an option by highlighting the option with the arrow keys and pressing ENTER.

The following chapters describe each of the options on the main screen except "Information" which is self explanatory. It starts with setting up the software since this must be done before any measurements can be made.

4.8 SHELLING TO MS-DOS

You can shell out from ROMDAS to MS-DOS at any time by pressing the ALT and F10 keys simultaneously. This cannot be done during a survey. Because of the size of the ROMDAS program you will be limited as to what you can do under MS-DOS.

WHAT CAN YOU RECORD IN THE DIFFERENT TYPES OF SURVEYS

Roughness Survey: You can record (1) the roughness; (2) keyboard events; (3) new location reference points; (4) the transverse profile; (5) GPS data; (6) skid resistance; (7) traffic counts.

Travel Time and Congestion Survey: You can record (1) speed; (2) keyboard events; (3) new location reference points; (4) GPS data; (5) skid resistance; (6) traffic counts.

Keyboard Rating Survey: You can record (1) keyboard events; (2) new location reference points; (3) the transverse profile; (4) GPS data; (5) skid resistance; (6) traffic counts.

Location Reference Point Survey: You can record (1) location reference points; (2) keyboard events; (3) the transverse profile; (4) GPS data; (5) skid resistance; (6) traffic counts.

© 2001Data Collections Ltd.

5. SETTING UP THE ROMDAS SOFTWARE

5.1 INTRODUCTION

Before using ROMDAS, the user must run the SETUP option. This allows certain important system parameters to be defined and various options selected. Selecting this option from the main menu gives the menu in Figure 5.1. The choices are:

- **Calibrate** - a calibration coefficient for the distance/speed sensor **must** be supplied before running ROMDAS.
- **Edit Data Files** - defines input data files for the surveys, such as keycode rating or LRP definitions.
- **Transverse Profile Logger** - settings for the ROMDAS TPL.
- **Customise** - custom settings such as the default file directory.
- **Options** - defines essential survey settings which are not usually accessed by the operators.

The following sections will discuss each of the menu options in detail.

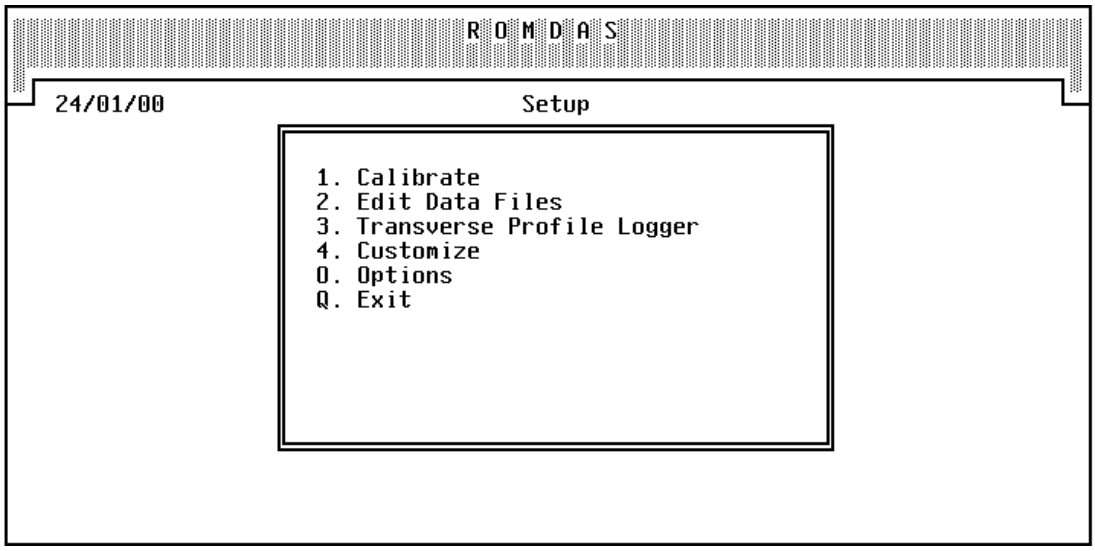


Figure 5.1: Setup Menu

Box 5.1 Before You Do Anything Else

Ensure that you have set the hardware interface version number otherwise the system will not work. See Section 5.6.1.

© 2001Data Collections Ltd.

5.2 CALIBRATE

This option is used to calibrate ROMDAS. The following calibrations can be done:

- Odometer
- Roughness Meter
- Transverse Profile Logger

A "Proximity Sensor" can be used to start and stop the recordings (see Section 5.6.1 and ANNEX I. The sensor should be connected to the reverse light input in the ROMDAS hardware and must provide a ON/OFF switch of 12 v. When the change in state is first noted the system will start recording; when it is noted a second time it will stop recording. This feature is used instead of having the operator manually start and stop the surveys and is important for ensuring accurate results. As described in ANNEX I, a simple sensor can be fabricated for little cost and these are often preferable to sophisticated sensors.

5.2.1 Calibrate Odometer

This option calibrates the distance/speed sensor. It is necessary to do this only once, but it is advisable to regularly check that the vehicle is still within calibration.

NOTE: The calibration MUST be done with the vehicle tyres at a 'standard tyre pressure' which is set either warm or cold. Each day, before commencing a survey, the tyre pressure should be checked to ensure that it is at the same standard pressure. For this reason, it is usually best for warm pressure to be used.

The calibration is done by firstly accurately measuring a known distance on the pavement. This must be at least 100 m long since ROMDAS will not allow you to use any shorter lengths. The longer the test section the better since it will minimise the impact of measurement errors.

The start and end points of the section should be marked on the pavement. The vehicle is then driven to the start section and the SPACE key is pressed. The section should be driven over and the vehicle stopped at the end of the section. At this point the SPACE key should be pressed again. The user will then be prompted for the distance travelled.

ROMDAS will use the user supplied distance in conjunction with the number of pulses from the distance/speed sensor recorded over the distance to determine a calibration constant which is displayed. This corresponds to the number of pulses/km. This constant is thereafter used to convert the distance/speed pulses to the actual distance travelled by the vehicle. The values are typically 2500/km with the standard sensors and over 100,000/km with the ROMDAS high resolution DMI.

It is recommended that you repeat this exercise several times to ensure that the ROMDAS calibration factor is correct. The user can manually override the factor displayed by entering a new value in the display. For example, when several runs are made and the calibration factors are similar the average[1] can be used.

[1] If you are certain that the vehicle travelled exactly between the same start and stop points the minimum should be used instead of the average since the longer distances are due to vehicle wander.

© 2001Data Collections Ltd.

5.2.2 Calibrate Roughness Meter

Roughness meter calibration is used to collect the data for converting the raw roughness counts into calibrated roughnesses. ANNEX J and ANNEX N describe running a calibration experiment and Section 5.3.2 describes how the results are applied.

The calibration entails driving the vehicle between a start and stop point and recording the number of raw counts over the interval as well as the average speed. It is performed in a similar manner as a roughness survey (see Chapter 6). The only major difference is that the user enters the length of the test section. The recording is started at the beginning of the section and is stopped automatically when this distance is reached.

5.2.3 Calibrate Transverse Profile Logger

Selecting this menu item gives three options:

- **Single Measurement**. Fires the transverse profile logger (TPL) once.
- **Multiple Measurements**. Fires the TPL continuously until a stop signal is given.
- **Create Datum Level**. Creates a calibration file with the relative elevations of each sensor.

Chapter 11 and ANNEX G describe the TPL calibration in detail.

Singe Measurement

When this option is selected, the operator enters the name of the file to store the data in (RAxxxxxx.DBF) and a description of the survey site. ANNEX M describes the file structure.

The operator can then specify whether or not to use a proximity sensor (see ANNEX I) to trigger the firing. This is only asked if the entry under **SETUP|OPTIONS|PROGRAM SETTINGS** (Section 5.6.1) for proximity sensor is specified as "Y". The user then indicates whether or not the TPL 'wings' are attached.

If a proximity sensor is to be used the vehicle should be driven to speed and the SPACE bar pressed to commence the speed recording. When the proximity sensor is triggered the TPL will be fired. The speed of the vehicle at the time of the firing is recorded along with the TPL measurements.
If a proximity sensor is not used, the vehicle should be positioned over the location to take the measurements and the SPACE bar pressed. The data will be stored when the ENTER key is pressed.

Multiple Measurements

This option consists of collecting TPL data at a regular intervals over a test section, or continually in the same location. The calibration is done in a similar manner to the single measurement described above. The operator enters the same data along with the sampling interval to take the TPL measurements at.

The data are stored in the file RBxxxxxx.DBF. It consists of the TPL readings, the vehicle speed and chainage where they were taken. ANNEX M gives an example of the TPL calibration data file structure. The calibration is stopped when the F10 key is pressed or the proximity sensor is triggered a second time.

The user has the option of using the ENTER key to take a reading. This is commonly used when marks have been made on the pavement and manual measurements have been

© 2001Data Collections Ltd.

taken. The TPL is then positioned over these marks and manually fired. This eliminates any longitudinal positioning problems when comparing the data.

It is recommended that the first 10 measurements be discarded when doing calibrations. This ensures that the instrument has stabilised.

Create Datum Level

There will always be a small difference in elevations between adjacent sensors. Since this will introduce a systematic error into the calculations, it is necessary to correct for this by creating a datum level.

The need for datum level can be visualised from the top illustration in Figure 5.2. When a straight-edge is below the sensors the individual sensors have different elevations to each other, even though in theory all should be identical. It should be noted that the differences are generally small (< 1 mm).

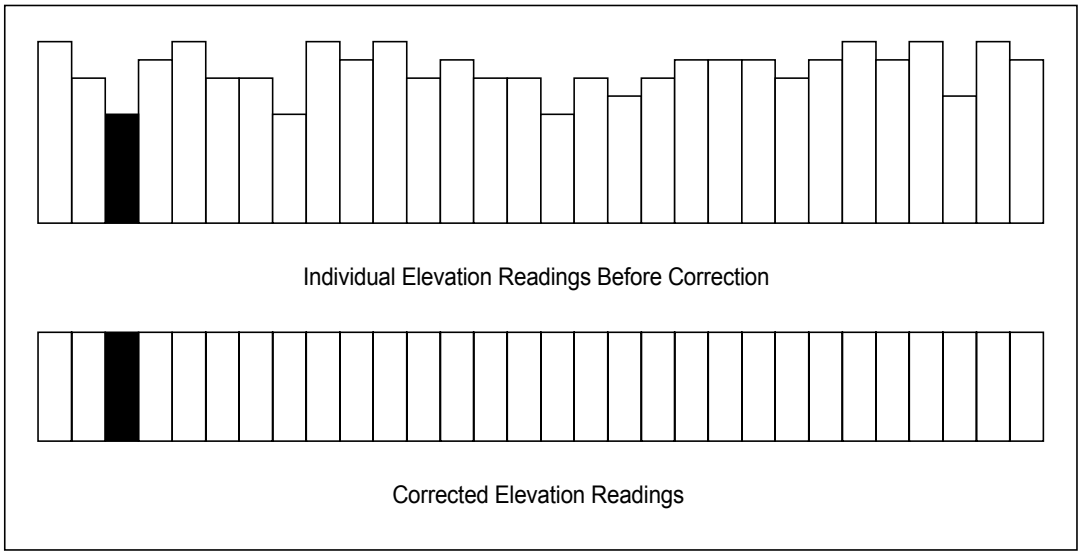


Figure 5.2: Datum Level Corrections

The data are corrected as follows:

- the minimum elevation is obtained from the individual readings. This is shown in Figure 5.2 by the shaded box in the top illustration.
- the difference between this elevation and the elevation for each sensor is calculated. This gives the correction factor for each sensor.
- the correction factor for each sensor (which is negative) is added to the elevation reading to obtain the corrected elevation. This results in the same corrected elevations for each sensor with the straight edge, as shown in the lower illustration in Figure 5.2.

The datum level data are stored in a file called CTxxxxxx.DBF. This is created as follows:

- hang a horizontal surface below the TPL. This may be a straight-edge or a trough full of water (see ANNEX G). It must be as close as possible parallel with the TPL which is why water works the best.
- the user runs a **Multiple Measurement** calibration.
- selecting the option **Create Datum Level**, the user is prompted for the file to use.

© 2001Data Collections Ltd.

- the average of each reading in the file is used to calculate the mean elevation for each sensor. This is corrected for temperature and measurement distance using the standard values defined by the user.
- the minimum elevation is established.
- the difference between this and the other averages is calculated and stored as the calibration factor.

It is recommended that this calibration be run daily so as to eliminate any potential errors due to vibration altering positions of the sensors, etc.

5.3 EDIT DATA FILES

Selecting this option gives access to defining four files which are very useful for conducting ROMDAS surveys:

- **Keycode Event Data** – assigns the keys of the computer to user definable events
- **Roughness Calibration Coefficients** – converts raw roughness counts to calibrated roughnesses
- **Survey Roughness Index Coefficients** – coefficients used during survey to display the roughness index instead of the raw roughness on the screen
- **Road Definition Data** – pre-defines road data and file identifications with ROADID values
- **LRP Definition Data** – pre-defines LRP descriptions
- **Traffic Count Flow Profiles** – data used for calculating ADT and AADT
- **Elevation Profile Data for IRI** – data on the elevation profile of the road (*e.g.* from a Dipstick or rod-and-level survey)

5.3.1 Edit Keycode Event Data

The keycode event file stores definitions on the events corresponding to each key on the computer keyboard. When one of the keys is pressed these definitions are used to establish the event and its chainage is recorded. As described in Section 2.2, there are two types of events recorded:

- **Continuous event** - an event on or adjacent to the road which applies over a section of the road (e.g. a cracked section)
- **Point event** - an event on or adjacent to the road which applies to a point (e.g. a traffic sign).

A **switch event** is a special case for continuous events. It is used when there are consecutive continuous events that would be applied on a section of road. For example, one may define the pavement condition using an index of 0 to 5. When there is a change in condition one would normally have to press the first event key to end the first event and a second key to start the second event. By using the switch event option only the second key would need to be pressed. This would stop the first event and start the second event[1].

As defined in Section 5.6.5, there are two options for the number of keys that can be used:

- **61 Keys**. This is the default setting and is more than enough for all but the most specialised of surveys. The keys are case insensitive so a 'c' is treated the same as a 'C'

[1] It is standard to always have one switch event applying to a section of road. If you want to completely stop the switch events this can be done using a switch described in Section 5.6.5.

© 2001Data Collections Ltd.

- **119 Keys**. It is recommended that this only be used in conjunction with the ROMDAS rating keyboards since this differentiates between the case of the letters, *ie* 'c' is different to 'C'.

To change the default setting from 61 to 119 go to **SETUP|OPTIONS|KEYCODE SETTINGS** and set 'Keycodes expanded from 61 to 119 keys' to **Y**.

The ROMDAS rating keyboards (see Section 2.5) is ideally suited to rating surveys.

It is entirely up to the user to define what events they would like to assign to keys. The A to Z or numeric keys may be used as well as combinations with the 'Control' key. These are displayed on the screen with a '^' before them when pressed.

Figure 5.3 illustrates the screen for editing the keycode file (without the moving traffic survey data) which has the fields:

EVENT	The key which corresponds to the event
EVENT_TYPE	The type of event: P Point C Continuous Others Switch event (any letters or numbers)
STOP_BI	Stop the roughness meter when key pressed: F Do not stop roughness measurements T Stop roughness measurements
RATING	Whether or not the key is a rating event. When pressed the operator can enter a numeric value [Not implemented]
EVENT_DESC	A description of the event
VEHICLE	Whether this keycode is used in traffic survey F Keycode is not used for vehicle T Keycode is used for vehicle
DIRECTION	The direction that the vehicle in traffic survey travels 0 Travelling in opposite direction 1 Overtakes the survey vehicle 2 Overtaken by the survey vehicle
REL_SPEED	Relative speed of the vehicle class (km/h)

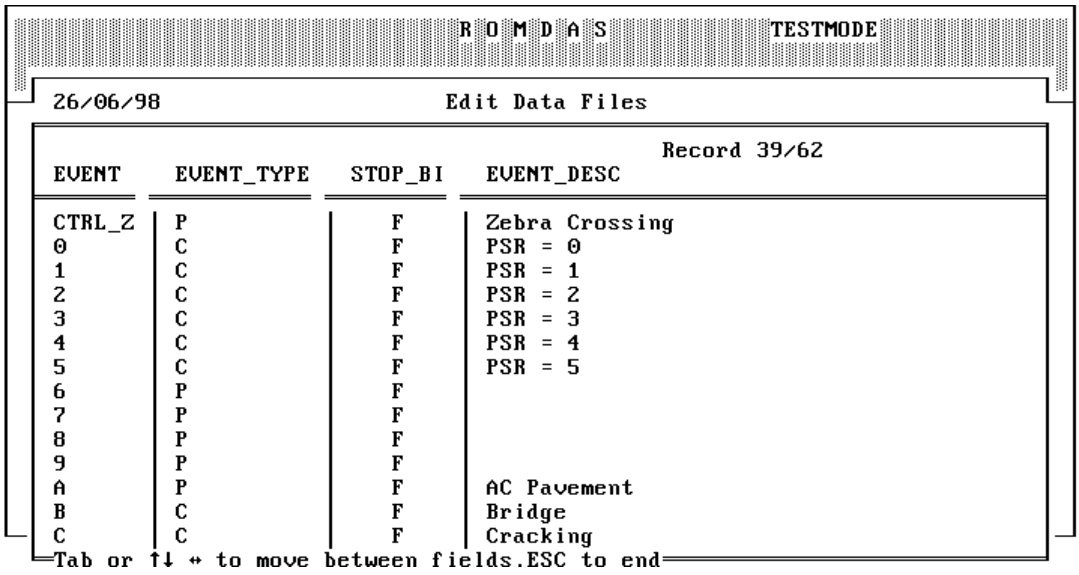

R O M D A S TESTMODE
26/06/98
Edit Data Files
Record 39/62
EVENT EVENT_TYPE STOP_BI EVENT_DESC
CTRL_Z P F Zebra Crossing
0 C F PSR = 0
1 C F PSR = 1
2 C F PSR = 2
3 C F PSR = 3
4 C F PSR = 4
5 C F PSR = 5
6 P F
7 P F
8 P F
9 P F
A P F AC Pavement
B C F Bridge
C C F Cracking
Tab or ↑↓ ↔ to move between fields.ESC to end

Figure 5.3: Edit Keycode File Screen

© 2001Data Collections Ltd.

You scroll through the file and assign your events to the keys. Select keys which are both readily accessible and easy to remember. You should also label the keys on the computer keyboard to identify the events they pertain to.

Under EVENT_TYPE when P is used it will be a point event with a single chainage stored. When C it is a continuous event which will have a start and end chainage. If any other letters or numbers are used they will be switch events. For example, one may define cracking as a switch event such as below:

EVENT	EVENT_TYPE	EVENT_DESC
A	S	No cracks
S	S	Low cracking
D	S	High Cracking
F	S	Extreme Cracking

The 'STOP_BI' option allows you to stop the recording of the roughness recordings when a key is pressed, for example when passing through a work zone or over a bridge. The data are converted to an equivalent roughness as described in Chapter 6.

The RATING field allows the operator to enter a numeric value after pressing the key. For example, the keycode may be defined as 'Cracking' and once selected the operator will then be prompted to enter a numeric value for the cracking level.

The vehicle data only needs to be supplied if you plan on using ROMDAS for moving traffic surveys (see Chapter 15).

5.3.2 Roughness Calibration Coefficients

Each vehicle responds differently to roughness due to variations in the springs, dampers and tyres. It is therefore essential to calibrate each roughness survey vehicle against a known roughness so that its measurements can be related back to such a roughness.

ANNEX J discusses calibrating roughness meters in detail and gives examples of calibration results as well as describing the software supplied with ROMDAS for calibrating roughness vehicles to IRI. Calibration is done by profiling a pavement test section with:

- TRL Merlin — Plans available from DCL
- TRL Beam
- A rod-and-level survey
- DIPSTICK
- ARRB Walking Profiler
- Vehicle Based Inertial Profilometer

The profiled data are used to calculate the standard roughness for the section which is usually in terms of the International Roughness Index, or IRI[1]. By running the survey vehicle over a number of profiled sections, each with different roughnesses, one can establish a relationship between the raw roughness count of the survey vehicle and the standard roughness.

ROMDAS can convert the raw roughness counts/km to the standard roughness. This is done by specifying a conversion equation of the form:

[1] The elevation data are used to calculate IRI through the option under **DATA MANAGEMENT/ROAD ROUGHNESS DATA/CALCULATE IRI FROM ROAD PROFILE**. A program for calculating the IRI is also supplied on the ROMDAS program disk. These are discussed in ANNEX J.

© 2001Data Collections Ltd.

$$CALIB\_RGH = A0 + A1 * RAW^{A2} + A3 * RAW^{A4} + A5 * \exp(A6\ RAW)$$

where CALIB_RGH is the calibrated roughness (usually in IRI m/km)
RAW is the raw roughness meter counts in counts/km
A0 to A6 are regression coefficients

The above formulation has been designed for the maximum flexibility. Not all coefficients will be used in a model as it is typical to have simple linear or polynomial functions.
The equations developed depend upon whether there is a single or dual BI installed in the vehicle (see Figure 3.4). If only a single roughness meter is used then only enter values for roughness meter 1. The calibrated roughness should be a single value for both wheelpaths. If dual BI units are used then the equations should be developed for each wheelpath. These are used separately to calculate the IRI and the mean IRI is included in the processed output.

The values of the coefficients A0 to A6 are determined by performing a regression analysis on a set of data values consisting of paired values of the profiled roughness and the raw roughness counts. To facilitate the analysis, the ROMDAS distribution disk contains a non-linear regression program[1]. During the installation of the software, this program is installed into the directory NLREGxx where xx is the current version number of the software (see Section 4.2).

The response of a vehicle to roughness is a function of speed. Thus, different equations will apply over different speeds. Since it is impossible to conduct a roughness survey at a constant speed, it is recommended that equations be developed for a range of speeds. This is done by repeating the calibration experiments with the vehicle operating at different speeds. In calculating the standard roughness one then uses the most appropriate equation for the vehicle speed during the survey.

This menu option in the ROMDAS software allows the user to enter the coefficients for the roughness calibration equation and the speeds which they apply to. The coefficients can be specified for different vehicles or else the same vehicle at different operating conditions, such as loading levels. The opening screen is illustrated in Figure 5.4.

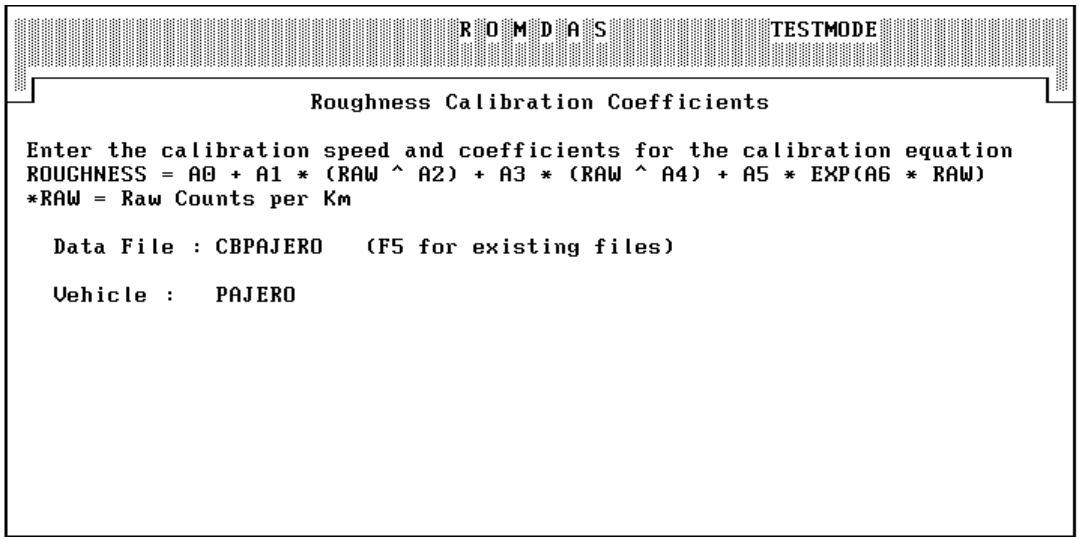

R O M D A S
TESTMODE
Roughness Calibration Coefficients
Enter the calibration speed and coefficients for the calibration equation
ROUGHNESS = A0 + A1 * (RAW ^ A2) + A3 * (RAW ^ A4) + A5 * EXP(A6 * RAW)
*RAW = Raw Counts per Km
Data File : CBPAJERO (F5 for existing files)
Vehicle : PAJERO

Figure 5.4: Screen for Defining Roughness Calibration Coefficient Files

[1] The program supplied is called NLREG and it is distributed with the permission of its author. NLREG is an extremely powerful yet easy to use regression package which runs under MS-DOS. It is distributed as Shareware so should you choose to continue using the program you are expected to register it with the author. Details of the current registration fee is supplied in the file REGISTER.DOC which is found in the subdirectory with the program.

© 2001Data Collections Ltd.

The data files are defined as CBxxxxxx, where xxxxxx is a user supplied identifier. This file name is placed in the files with the calibrated roughness output so that you know which equations were used. You must also enter in the vehicle identification number which will be used in the survey. When calculating the calibrated roughness, the software checks to ensure that the same vehicle identification number was used in the original survey.

Once you have defined these, you are able to enter the values for the coefficients. The values are entered for different speeds and the equation will be used for all speeds below the mean of the previous and following speeds. For example, if equations were supplied for 50 and 100 km/h the first equation would be used for speeds below 75 km/h and the second for speeds above 75 km/h. It should be noted that the speed used is that recorded by ROMDAS, and not the vehicle odometer.

Figure 5.5 is an example of the input screen. The first column is the BI number which should be set to 1 unless you are using two BI. It will be noted that you can enter different equations for each BI.

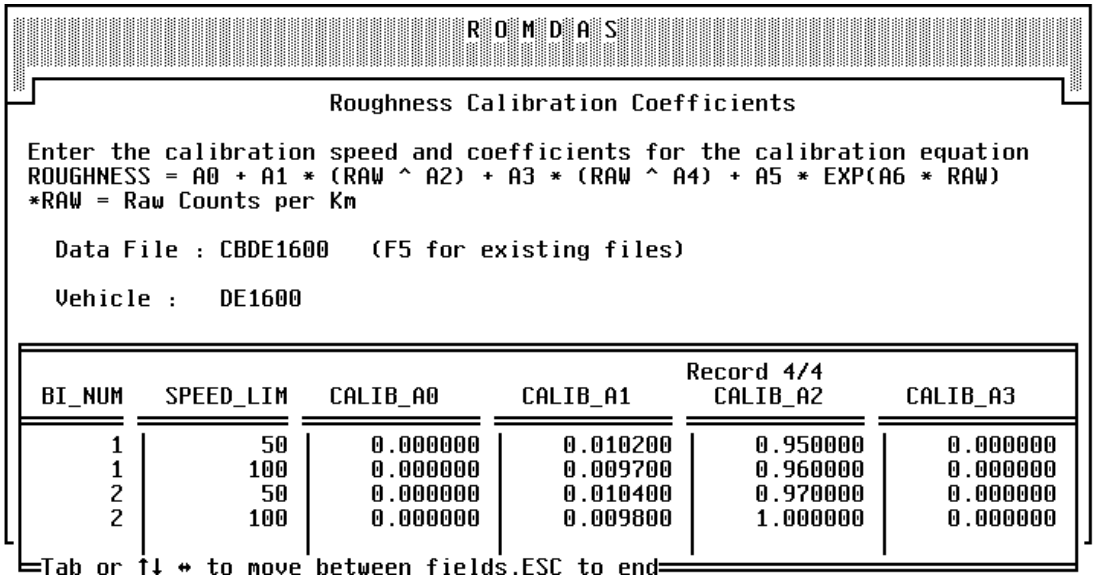

R O M D A S
Roughness Calibration Coefficients
Enter the calibration speed and coefficients for the calibration equation
ROUGHNESS = A0 + A1 * (RAW ^ A2) + A3 * (RAW ^ A4) + A5 * EXP(A6 * RAW)
*RAW = Raw Counts per Km
Data File : CBDE1600 (F5 for existing files)
Vehicle : DE1600
Record 4/4
BI_NUM SPEED_LIM CALIB_A0 CALIB_A1 CALIB_A2 CALIB_A3
1 50 0.000000 0.010200 0.950000 0.000000
1 100 0.000000 0.009700 0.960000 0.000000
2 50 0.000000 0.010400 0.970000 0.000000
2 100 0.000000 0.009800 1.000000 0.000000
Tab or ↑↓ ↔ to move between fields.ESC to end

Figure 5.5: Roughness Calibration Equation Coefficients

NOTE: The calibrated roughness is based on the number of counts per km. This means that the raw data is first converted to the number per km based on the measured sampling interval. For example, if you calibrate over a 200 m section you would multiply the raw counts by 5 to get the total per km. The calibration conversion equations you develop must therefore also be based on per km measurements for the results to be valid.

5.3.3 Survey Roughness Index Coefficients

By default, the displays during the roughness surveys show the raw ROMDAS roughness in terms of counts per sampling interval. This is done since the vehicle may not be in calibration for the full survey and so different calibration coefficients may apply to different parts of the survey. However, there are times when it is desirable to have an approximate estimate of the roughness displayed—for example when doing video surveys which have the roughness superimposed on the image. In these instances, the **roughness index** can be used.

© 2001Data Collections Ltd.

The roughness index is calculated in a similar manner to the calibrated roughness. The only difference is that instead of having several calibration equations for different speeds a single equation is used for all speeds. This constraint is required due to the computational intensity of ROMDAS as a real-time data collection system. As shown in Figure 5.6, the data are entered in a similar manner to the roughness calibration coefficients and the same basic model form is used. By setting the **Display Roughness Index instead of BI** to **Y** this data will be displayed during the surveys.

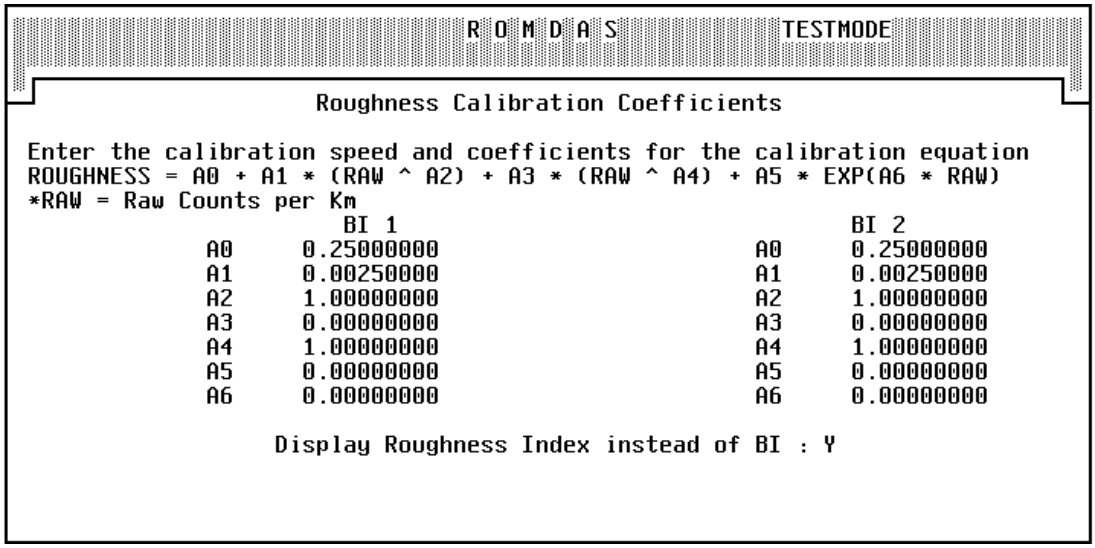

R O M D A S TESTMODE
Roughness Calibration Coefficients
Enter the calibration speed and coefficients for the calibration equation
ROUGHNESS = A0 + A1 * (RAW ^ A2) + A3 * (RAW ^ A4) + A5 * EXP(A6 * RAW)
*RAW = Raw Counts per Km
BI 1
A0 0.25000000
A1 0.00250000
A2 1.00000000
A3 0.00000000
A4 1.00000000
A5 0.00000000
A6 0.00000000
BI 2
A0 0.25000000
A1 0.00250000
A2 1.00000000
A3 0.00000000
A4 1.00000000
A5 0.00000000
A6 0.00000000
Display Roughness Index instead of BI : Y

Figure 5.6: Survey Roughness Index Coefficients

5.3.4 Edit Road Definition Data

The Road Definition data file contains roughness survey information pertaining to each Road ID. When the user types the Road ID on the survey opening screen these data are inserted into the appropriate fields. This feature allows the survey manager to ensure consistency in naming conventions, *etc.* The file contains data on:

- Road ID
- Survey file name. This must have the prefix RR if it is for roughness surveys; RP for LRP surveys and RK for keycode surveys.
- LRP File name
- Road Description
- LRP resets (Y/N/D)
- Optional user defined fields (USER_1 to USER_3)

5.3.5 Edit LRP Definition Data

The LRP Definition data work in a similar manner to the Road Definition data. The user can define a short code of up to four characters/numbers. When doing an LRP survey, or defining LRPs in a roughness survey, the operator holds the ALT key and types in these codes. The data in the LRP Definition file is then inserted into the entry for the description of the LRP. This feature ensures consistency in defining LRPs between surveys or with different survey teams.

Figure 5.7 illustrates the LRP definition file input data. The LRP key can be between 2 and 6 characters and is defined as described in Section 5.6.4.

© 2001Data Collections Ltd.

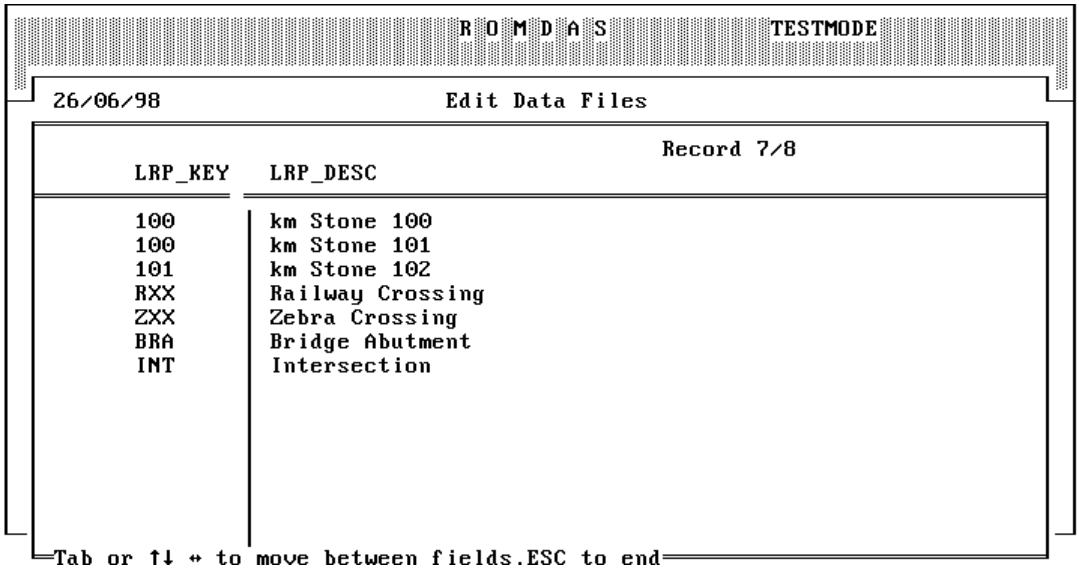


Figure 5.7: LRP Definition File

5.3.6 Edit Traffic Count Flow Profiles

The traffic count flow profiles are used to convert the moving traffic survey data to an ADT and an AADT. There are two profiles which are required:

- **ADT Adjustment Factor** – used to correct for the time of day and duration of the survey
- **AADT Adjustment Factor** – used to correct for the day of week and month of year of the survey.

A description of how these data are established is given in Section 15.2. Figure 5.8 shows the input for the ADT flow profile using data from Section 15.2.

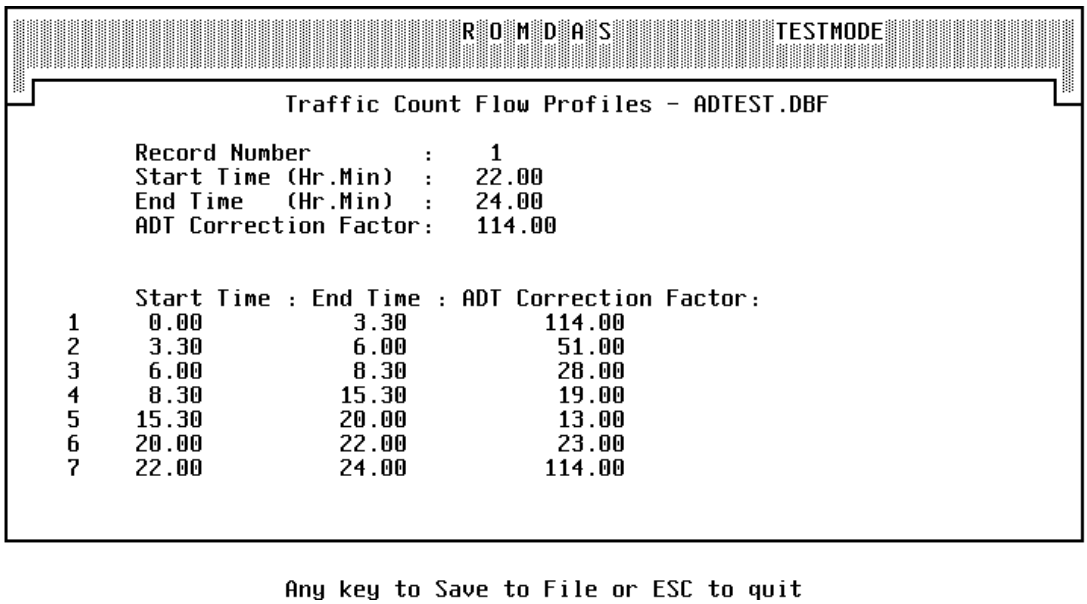

R O M D A S TESTMODE
Traffic Count Flow Profiles - ADTEST.DBF
Record Number : 1
Start Time (Hr.Min) : 22.00
End Time (Hr.Min) : 24.00
ADT Correction Factor: 114.00
Start Time : End Time : ADT Correction Factor:
1 0.00 3.30 114.00
2 3.30 6.00 51.00
3 6.00 8.30 28.00
4 8.30 15.30 19.00
5 15.30 20.00 13.00
6 20.00 22.00 23.00
7 22.00 24.00 114.00
Any key to Save to File or ESC to quit

Figure 5.8: ADT Flow Profile

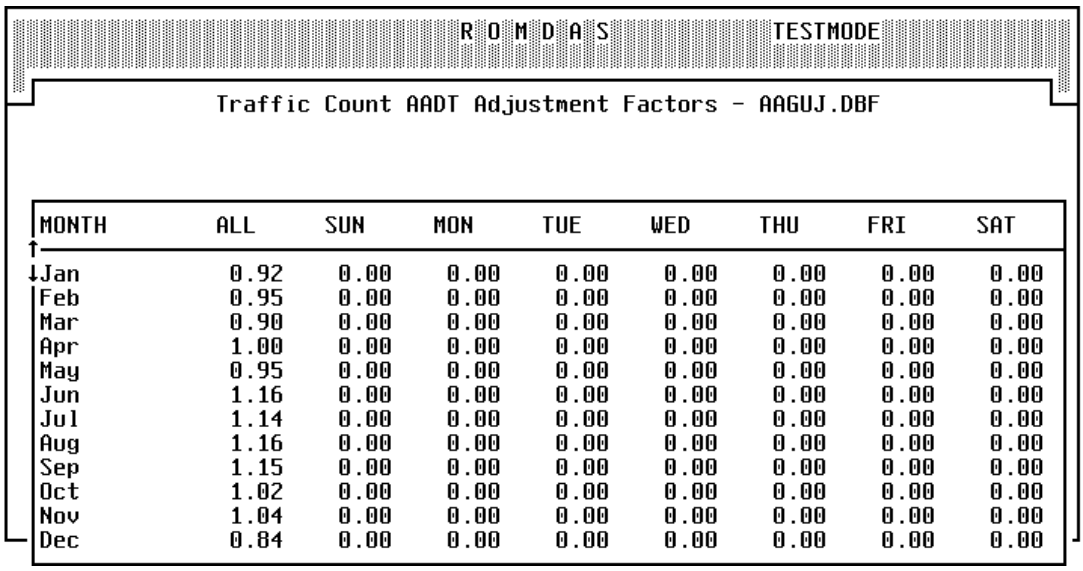
These data are used to multiply the **average hourly** flow to convert it to an AADT. Thus, if an hourly flow of 1000 veh/h was observed between 06:00 and 08:30 the ADT would be

© 2001Data Collections Ltd.

20,000 veh/day. Observing a flow of 392 veh/h between 03:30 and 06:00 would also give us the same ADT.

It should be noted that the data spans midnight since there was a constant flow profile from 22:00 – 03:30. This requires two different settings: 0:00 – 03:30 and 22:00 – 24:00. When the data are entered the user always starts at 0:00 and enters the end time for the interval. That end time then becomes the start time for the next interval until data have been entered for the entire 24 h period.

An AADT flow profile is illustrated in Figure 5.9. This data is used to convert the ADT to an AADT based on monthly and, optionally, daily factors. In the above example if the ADT of 20,000 veh/day was calculated in February, the AADT would be taken as 0.95 x 20,000 = 19,000 veh/day. It would be 23,000 veh/day in September.



MONTH	ALL	SUN	MON	TUE	WED	THU	FRI	SAT
Jan	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 5.9: AADT Flow Profile

5.3.7 Edit Elevation Profile Data for IRI

This option is used to create an elevation profile file for calculating the IRI. When selected, the user is prompted to enter a file name (RZ is used as the prefix) and is then given the screen shown in Figure 5.10. The interval between elevation measurements (in m) and the elevations (in mm) are entered.

© 2001Data Collections Ltd.

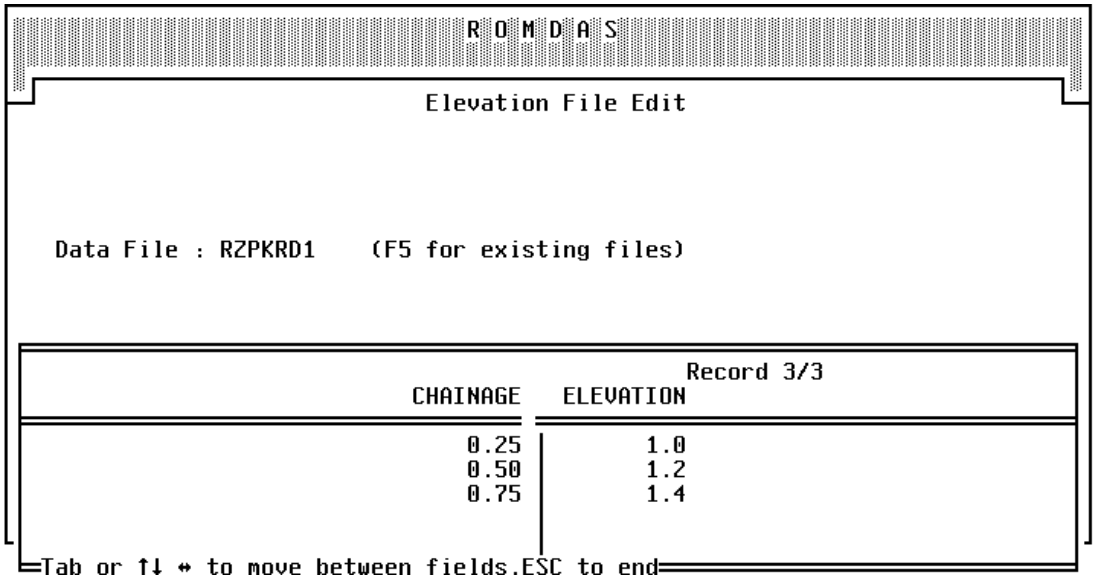

R O M D A S
Elevation File Edit
Data File : RZPKRD1 (F5 for existing files)
Record 3/3
CHAINAGE ELEVATION
0.25 1.0
0.50 1.2
0.75 1.4
Tab or ↑↓ ↔ to move between fields.ESC to end

Figure 5.10: Editing Elevation Profile Data

5.4 TRANSVERSE PROFILE LOGGER

5.4.1 Introduction

As shown in Figure 5.11, there are seven options for setting up the TPL:

- **TPL Setup**. Defines the basic setup parameters for the TPL.
- **TPL Analysis Options**. Options for analysing TPL data.
- **TPL Error Corrections**. Defines how erroneous readings are treated.
- **Define Standard Conditions**. Displays the average reading of the fixed sensor used to correct for ambient conditions.
- **TPL Sensor Numbering**. Confirms that the TPL sensors are numbered sequentially across the housing and allows for numbers to be reversed.
- **TPL Diagnostics**. Used when there is a problem or when a measurement array must be replaced. This is described in ANNEX G.
- **Crossfall Calculations**. How crossfall is calculated with from the TPL data.

When the TPL is first installed one defines the standard conditions and confirms the sensor numbering. These values are not altered except in unusual circumstances – such as if a measurement array is replaced and the numbers are out of sequence. The other options may be altered infrequently as survey requirements demand it.

5.4.2 TPL Setup

This option inputs the basic data for use with the Transverse Profile Logger (TPL) setup. Figure 5.12 shows the screen for entering these setup data. The data required are as follows.

© 2001Data Collections Ltd.

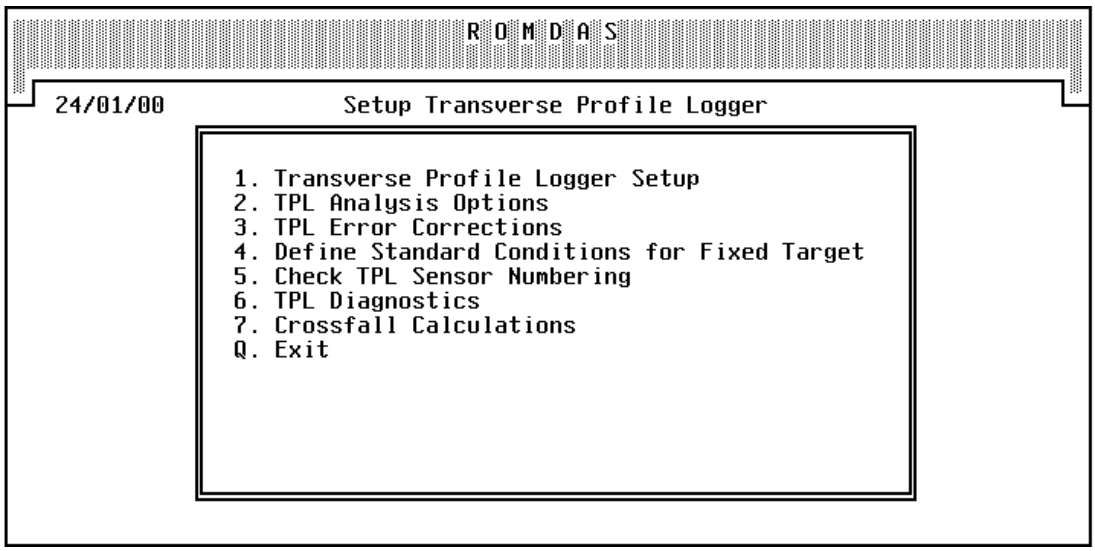

R O M D A S
24/01/00
Setup Transverse Profile Logger
1. Transverse Profile Logger Setup
2. TPL Analysis Options
3. TPL Error Corrections
4. Define Standard Conditions for Fixed Target
5. Check TPL Sensor Numbering
6. TPL Diagnostics
7. Crossfall Calculations
Q. Exit

Figure 5.11: TPL Options

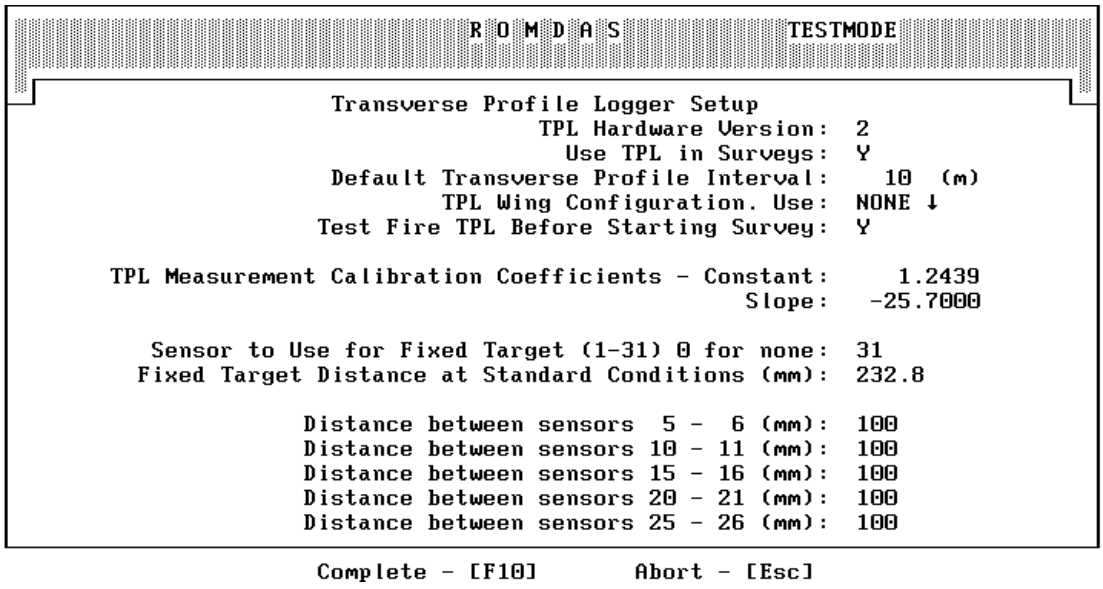

R O M D A S TESTMODE
Transverse Profile Logger Setup
TPL Hardware Version: 2
Use TPL in Surveys: Y
Default Transverse Profile Interval: 10 (m)
TPL Wing Configuration. Use: NONE ↓
Test Fire TPL Before Starting Survey: Y
TPL Measurement Calibration Coefficients - Constant: 1.2439
Slope: -25.7000
Sensor to Use for Fixed Target (1-31) 0 for none: 31
Fixed Target Distance at Standard Conditions (mm): 232.8
Distance between sensors 5 - 6 (mm): 100
Distance between sensors 10 - 11 (mm): 100
Distance between sensors 15 - 16 (mm): 100
Distance between sensors 20 - 21 (mm): 100
Distance between sensors 25 - 26 (mm): 100
Complete - [F10] Abort - [Esc]

Figure 5.12: Transverse Profile Logger Setup Screen

TPL Hardware Version

All systems except the prototypes have the hardware version 2 or greater.

Use TPL in Surveys

This defines the setting on the survey opening screen. If you are always using a TPL set this value to Y.

© 2001Data Collections Ltd.

Default Transverse Profile Interval

This is the distance in m where transverse profile measurements will be taken. Since the firing of the sensors is staggered (see Figure 11.1), the first sensor in each array is fired at this distance. The subsequent sensors are fired within about 0.1 ms of this distance.

TPL Wing Configuration

The TPL can be operated in four possible wing configurations:

- **None**. The TPL wings are not used;
- **1-5**. Only the wing with sensors 1-5 is used;
- **26-30**. Only the wing with sensors 26-30 is used; or,
- **Both**. Both wings are used.

The user should define the configuration before starting the survey. The output file will then contain details as to the configuration adopted in the survey.

Test Fire TPL Before Survey

This option displays the readings of the TPL sensors before the survey starts. It is a useful check that all sensors are working since the TPL does not return error messages during the survey.

TPL Measurement Calibration Coefficients

The user can calibrate the TPL readings by comparing the measured output with a known distance. This is done as described in ANNEX G and results in a linear equation between the measured and actual distance. The user enters the slope and constant of this regression here. The defaults are 0 with Figure 5.12 showing values entered from a calibration.

Sensor to Use for Fixed Target

Normally, Sensor 31 is used for the fixed target. However, in the event of problems with that sensor the fixed target can be assigned to a different sensor. It will be necessary to block off this sensor, for example by connecting a tube with a fixed end. If the value is set to 0 the fixed sensor corrections are ignored.

Fixed Target Distance at Standard Conditions

As described in ANNEX G, the TPL has a sensor firing at a fixed target. The user enters the distance to the target (in mm) under the standard conditions. These standard conditions are user selected and represent a base altitude, temperature and atmospheric pressure.

The fixed target value can be established manually or, as described in Section 5.4.5, the software will calculate the standard value from test data and automatically update this entry.

Spacings Between Sensors

The TPL consists of up to 6 sets of sensor arrays. The data entered here consists of the distance (in mm) between the sensor arrays. It is measured from the right side of adjacent

© 2001Data Collections Ltd.

sensors. As shown in ANNEX G, the sensors are numbered continuously from one wing (1) to the other wing (30) across the housing.

5.4.3 TPL Analysis Options

This menu gives access to the options for analysing the TPL data. Figure 5.13 shows the screen for this menu.

```
R O M D A S                                   TESTMODE

                Transverse Profile Logger Analysis Options


Straight-edge Calculation Parameters
            Distance from Edge to Test for High Point (m):  0.6
                  Length of Left Wheel straight edge (m):  2.0
                 Length of Right Wheel straight edge (m):  2.0
      TPL Measurement Calibration Coefficients - Constant:    -3.0000
                                                 Slope:      1.0000

Pseudo-rut Calculation Parameters
                         Sensors to look for low point 1:   6   10
                         Sensors to look for high point :  11   20
                         Sensors to look for low point 2:  21   25
      TPL Measurement Calibration Coefficients - Constant:    -3.0000
                                                 Slope:      1.0000


                Complete - [F10]        Abort - [Esc]
```

Figure 5.13: TPL Analysis Options

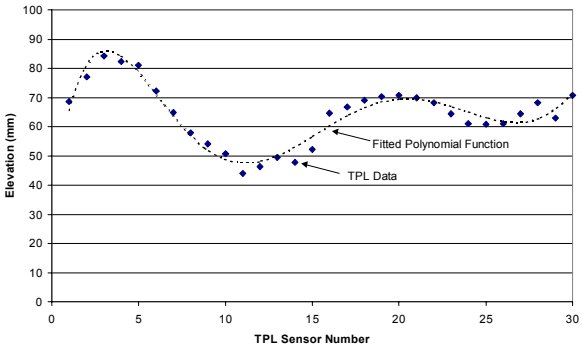
As described in Chapter 11, there are two methods for calculating rutting:

- **Straight-edge**. The rut depth is calculated under a user-defined simulated straight-edge.
- **Pseudo-rut**. This is the maximum difference in height between the wheelpath and the crown between the wheelpaths

Straight-edge rut depths are really only meaningful when the rut bar extends over the full width of the ruts. Thus, if one is using only the 2 m section it may be appropriate to use pseudo-ruts.

Smooth Data Using Polynomial Function

TPL measurement data can often have 'noise' in it wherein the measurements may give rise to inaccurate estimates of rut depth because of a single sensor. The user can 'smooth' the data using a 6th degree polynomial function by setting this option to Y. The figure to the right shows the function fitted to actual data. When selected, the data in the output file are predicted from the polynomial and are used to calculate the rut depths.



© 2001Data Collections Ltd.

Distance From Edge to Test for High Point

The rut depth analysis algorithm tests a variety of possible starting points to establish the high point for the straight edge (see Chapter 11). The is to test for the high point within 0.6 m of the pavement edge. This value can be increased to 1.2 m.

Length of Straight Edge

The rut depths are calculated under a user-defined straight edge length. This can be any length from 0.2 to 2.5 m in 0.1 m intervals. Different straight edge lengths can be used in the left and right wheelpaths, although it defaults to the same length.

TPL Measurement Coefficients

These values are provided to allow for a correction for a bias in the TPL measurements. It has been found that on some heavily textured surfaces there is a bias of 3 mm in the predictions. The data here are used in a regression equation to adjust the predictions. They should be set after a calibration against manual measurements based on local conditions.

Pseudo-rut Calculation Parameters

These entries give the sensor numbers where the high and low points will be located for calculating the pseudo-rut depths. Here, only the main bar is used so the rutting is assumed to be in the first 5 sensors to the left (6-10) and the last 5 sensors at the right (21-25). The high point will be between sensors 11-20. As with the straight-edge, calibration coefficients are provided to correct for any biases when compared to a straight-edge measurement.

5.4.4 TPL Error Corrections

The TPL Error Corrections are applied when processing the raw TPL data. Figure 5.14 shows the corrections that can be made to the data.

- **Maximum and Minimum Readings**. The TPL sensors may occasionally 'range out' which sees them giving excessively high values. Less frequent are excessively low values. Since these will lead to silly estimates of the rut depth they should be corrected. The values entered here should represent the maximum and minimum likely values expected and any reading exceeding these is treated as a bad reading to be corrected. They should be based on the height of the TPL sensors above the pavement and the expected rutting levels.
- **Incremental Differences**. Unless you are dealing with a highly discontinuous pavement, or going over the pavement edge, there will not be large incremental differences between adjacent sensors. If the values are outside of the limit set here the reading is treated as a bad reading to be corrected.
- **Zero Elevations**. When a sensor fails it returns a zero elevation. Setting this option to 'Y' sees these readings corrected.
- **Replace Zero Values**. When the TPL wings are not used all sensors return a zero value. Selecting this option sees all these values replaced by the first good reading (*i.e.* reading which does not fail the above three tests) from the main section of the TPL.

When a TPL reading fails one of the first three tests and corrections have been requested, it is treated as a bad reading. The data are corrected by linearly interpolating the elevations from the adjacent good readings.

© 2001Data Collections Ltd.

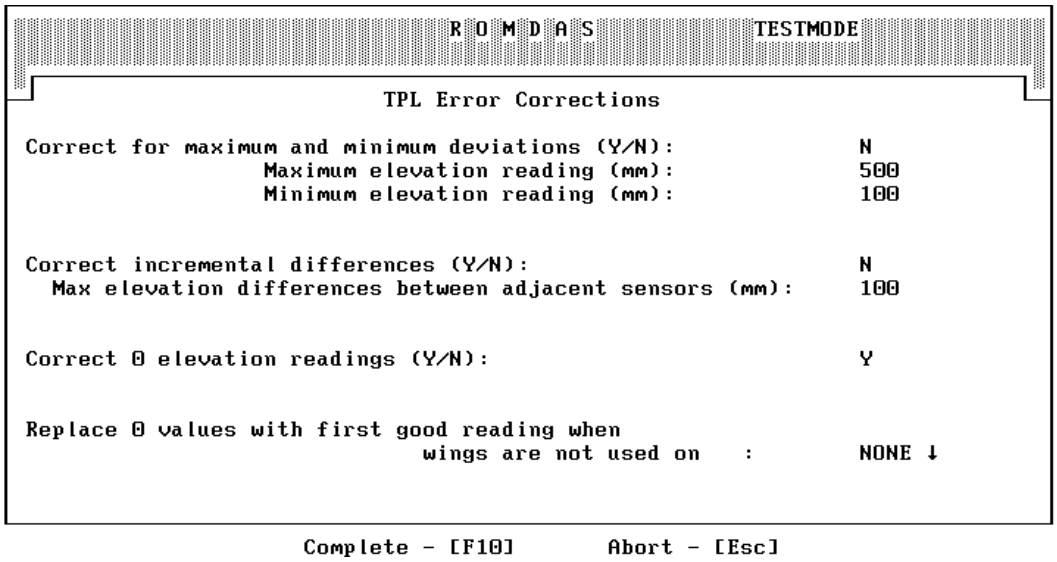

R O M D A S TESTMODE
TPL Error Corrections
Correct for maximum and minimum deviations (Y/N): N
Maximum elevation reading (mm): 500
Minimum elevation reading (mm): 100
Correct incremental differences (Y/N): N
Max elevation differences between adjacent sensors (mm): 100
Correct 0 elevation readings (Y/N): Y
Replace 0 values with first good reading when
wings are not used on : NONE ↓
Complete - [F10] Abort - [Esc]

Figure 5.14: TPL Error Corrections

5.4.5 Define Standard Conditions for Fixed Target

The TPL has a fixed sensor which is used to correct for ambient conditions (altitude, temperature and humidity). As described in ANNEX G, if the value of the fixed sensor changes by –10% the values for all other sensors are changed by +10% to correct for ambient conditions.

When this entry is displayed the screen shows the instantaneous value for the fixed target reading as well as the mean. A sufficient number of readings (minimum 1 minute) should be taken and the mean reading recorded. Pressing F10 halts the calculations. The user can then optionally update the standard fixed target distance described in Section 5.4.2 with this value.

5.4.6 Check TPL Sensor Numbering

The TPL sensors must be numbered sequentially from kerb to centreline across the TPL housing. If this is not done the software will incorrectly report the rutting in the left and right wheelpaths. It is also essential that they numbering be sequential (1 to 30) otherwise the calculations will be wrong.

There are two steps in the process:

1. Ensure that sensor 1 is at the vehicle kerb.
2. Ensure that the numbering is sequential.

Ensure Sensor 1 is at the Kerb/Edge of Road

This is done with the TPL mounted on the vehicle and both wings extended. The process is as follows:

1. Start **SETUP|CHECK TPL SENSOR NUMBERING**. The screen will display the elevation readings for each sensor.
2. Have an assistant go to the sensor which is closest to the vehicle kerb and put a hand over the foam cover on the sensor.

© 2001Data Collections Ltd.

3. If the arrays are in the correct order, either sensor number 1 or 5 will go to 0. No further actions are required.
4. However, if sensor 26 or 30 goes to 0 the arrays are reversed. Press the F8 key to invert the order of the arrays. When this is pressed what was array 6 goes to 1; 5 to 2; 4 to 3; 3 to 4; 2 to 5 and 1 to 6.
5. Repeat step 3 to confirm that the arrays have been correctly reversed.

Ensure Sequential Numbering

There are two stages to sequential numbering. Firstly, one must ensure that the sensors are correctly ordered from 1 to 6 (*i.e.* 1-2-3-4-5-6 not, for example, 1-3-2-4-5-6). This is done by starting **SETUP|CHECK TPL SENSOR NUMBERING** and having an assistant place their hand under each of the arrays. The values on the array will change and it can be confirmed that they are in the correct order. Having done this, we then confirm that they are numbered from 1-30 as follows:

1. The assistant should go to the kerb side wing and put their hand under the sensor closes to the kerb.
2. The height for sensor 1 should change. If, however, sensor 5 changes this means that the numbering is reversed.
3. Pressing the F1 key will reorder the sensor numbering. Repeat 2. to ensure that sensor 1 is now adjacent to the kerb.
4. Repeat steps 1 to 3 for each of the arrays in sequence.
5. Once you have checked all 6 arrays, have the assistant put their hand under each sensor from 1 to 30 and confirm from the screen that they are in the correct order.

NOTE: The TPL sensor numbers are stored in the file TPLORDER which is in the directory where the ROMDAS software is run from. This file must be present for the calculations to be correct. If the ROMDAS software is moved to another directory the file must be moved with it.

5.4.7 TPL Diagnostics

This menu item gives access to the TPL diagnostics menu. A description of how to use these options is given in ANNEX G.

5.4.8 Crossfall Calculations

This option is used to set up the ROMDAS pavement crossfall calculation options. A detailed description of the methodology is given in Chapter 12.

When selected the screen shown in Figure 5.15. The first entry is whether or not to do crossfall calculations (default=N). There are four different options provided for calculating crossfall (see Chapter 12):

- **Regression:** fits a linear regression relationship to the TPL data
- **Calibrated:** uses a correlation equation
- **Wheelpath Elevations:** uses difference in wheelpath elevations
- **Edge Elevations:** uses difference in edge elevations

The default option is to use a regression equation.

© 2001Data Collections Ltd.

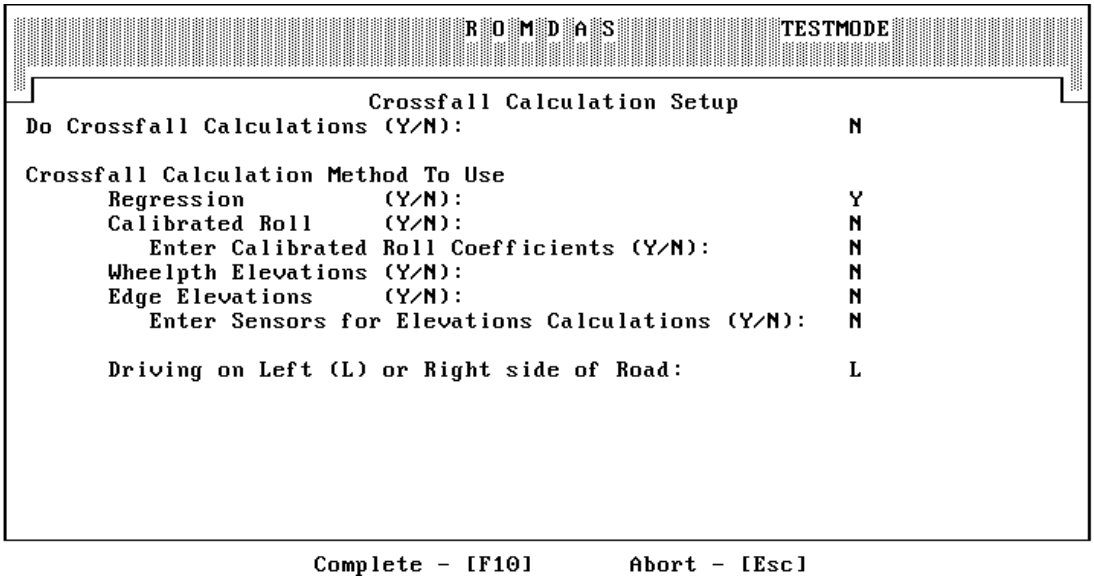

R O M D A S TESTMODE
Crossfall Calculation Setup
Do Crossfall Calculations (Y/N): N
Crossfall Calculation Method To Use
Regression (Y/N): Y
Calibrated Roll (Y/N): N
Enter Calibrated Roll Coefficients (Y/N): N
Wheelpth Elevations (Y/N): N
Edge Elevations (Y/N): N
Enter Sensors for Elevations Calculations (Y/N): N
Driving on Left (L) or Right side of Road: L
Complete - [F10] Abort - [Esc]

Figure 5.15: Crossfall Calculation Options

When the 'Calibrated Roll' option is selected, the crossfall is calculated from an equation of the form:

$$XFALL = A0 + A1 * ROLL^{A2} + A3 * ROLL^{A4} + A5 * \exp(A6\ ROLL)$$

where XFALL is the pavement crossfall in degrees
ROLL is the vehicle roll from the gyroscope in degrees
A0 to A6 are regression coefficients

The above formulation has been designed for the maximum flexibility. Not all coefficients will be used in a model as it is typical to have simple linear or polynomial functions.

The values of the coefficients A0 to A6 are determined by performing a regression analysis on a set of data values consisting of paired values of the pavement crossfall and gyro readings. To facilitate the analysis, the ROMDAS distribution disk contains a non-linear regression program[1]. During the installation of the software, this program is installed into the directory NLREG34 (see Section 4.2).

The response of a vehicle to crossfall may be a function of speed. Thus, different equations could apply over different speeds. Since it is impossible to conduct a roughness survey at a constant speed, it is recommended that equations be developed for a range of speeds. This is done by repeating the calibration experiments with the vehicle operating at different speeds. In calculating the crossfall ROMDAS uses the most appropriate equation for the vehicle speed during the survey.

The 'Wheelpath' and 'Edge' elevations options use the difference on elevations between sensors for calculating crossfall (see Chapter 12). The user can define up to 3 sensors for the left and right side of the TPL. The average elevation of these sensors are used in the calculations.

[1] The program supplied is called NLREG and it is distributed with the permission of its author. NLREG is an extremely powerful yet easy to use regression package which runs under MS-DOS. It is distributed as Shareware so should you choose to continue using the program you are expected to register it with the author. Details of the current registration fee is supplied in the file REGISTER.DOC which is found in the subdirectory with the program. The terms of usage are given in the file READ.ME which is in the same subdirectory.

© 2001Data Collections Ltd.

It is important to specify which side of the road the vehicle is driven on to ensure the correct sign for the crossfall.

5.5 CUSTOMISE

This option is used to customise general settings for running ROMDAS. Specialised settings, which are normally set by a survey administrator, are defined under **SETUP|OPTIONS**.

5.5.1 Default Directory

As described in Chapter 4, ROMDAS places its files in a series of subdirectories under the main directory. By default this main directory is the directory where the ROMDAS executable file is located, however, a different directory can be specified using this option.

Figure 5.16 shows the options for defining the directory. There is the basic directory where data are stored (here **c:\ROMDAS**) and then the option to store data in 'Daily' sub-directories.

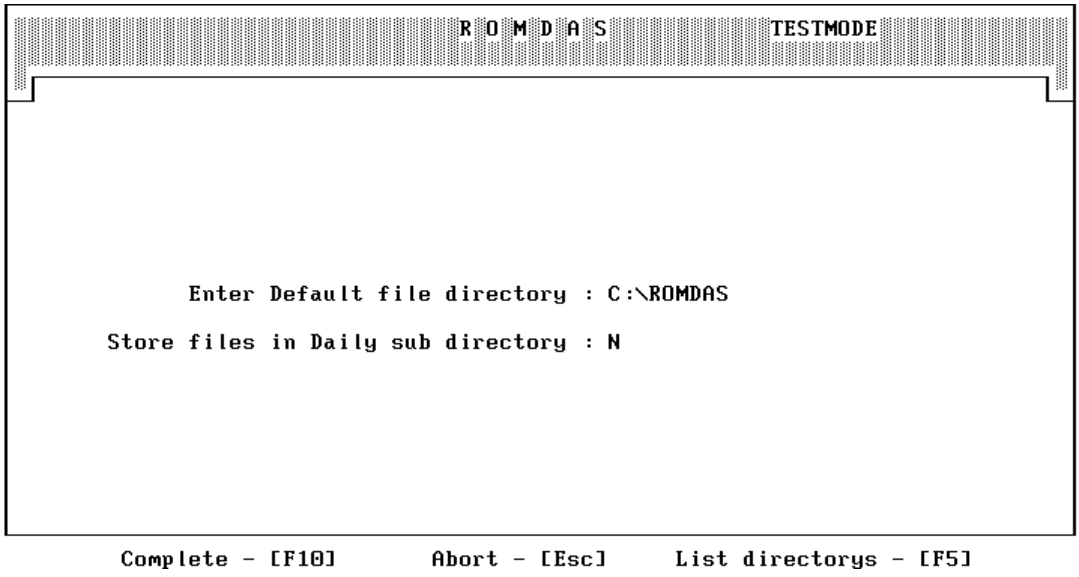

R O M D A S
TESTMODE
Enter Default file directory : C:\ROMDAS
Store files in Daily sub directory : N
Complete - [F10]
Abort - [Esc]
List directorys - [F5]

Figure 5.16: Default Directory Options

When the daily sub-directory option is selected the data are stored in subdirectories under the default file directory with a new directory created each day of the survey. The directories have the name YYYYMMDD, where YYYY is the year; MM the month and DD the day. For example, 31 January 2000 would be stored in 20000131 and the first of February 2000 in 20000201.

This option is useful when there are large surveys underway with potentially a large number of files being created. It greatly facilitates data management.

5.5.2 Define Pause Key

When you wish to pause a survey, by default you press the SPACE bar. However, some users have reported problems with this being accidentally pressed during the survey. This

© 2001Data Collections Ltd.

option allows you to assign the pause function to either the F3 or the F6 key. When selected, the display shown in Figure 5.17 is given. By pressing the ENTER key you are given a list box to select the key for pausing the survey. Use the arrow keys to highlight the appropriate entry and press ENTER.

It is recommended that you label the keyboard with which key has the pause function to remind the operator.

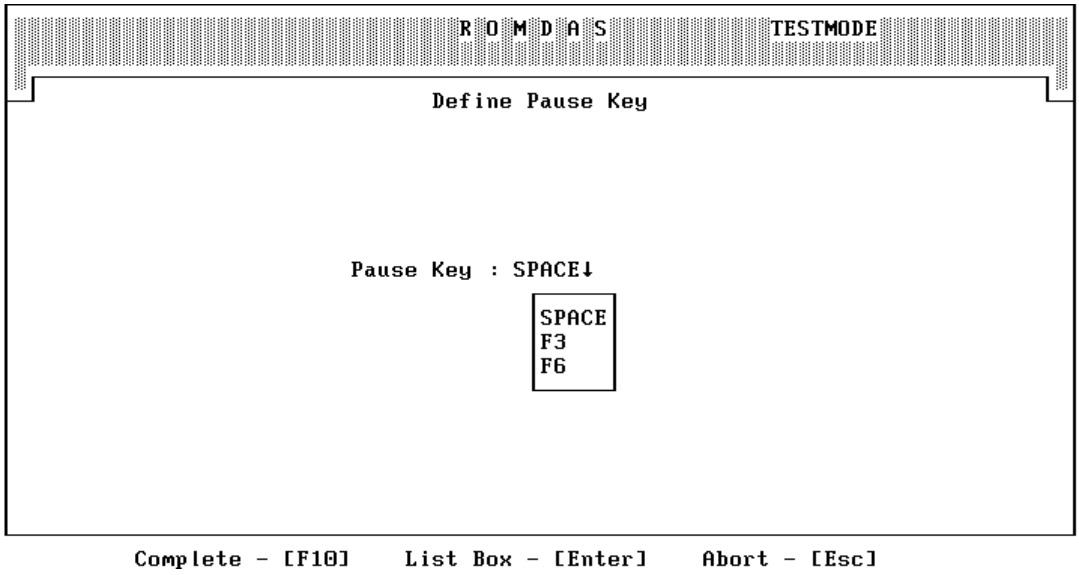


Figure 5.17: Display for Defining Pause Key

5.5.3 Assign Mouse Buttons

If a PS/2 style mouse port is available on the computer, it is possible to use a mouse with ROMDAS. The mouse is **NOT** used to select menu items as in other programs. Instead, it is used to replace the need for keyboard entry. The user can assign any keyboard keys to the mouse buttons (one per button). This allows for the operator to hold the mouse and not have to worry about using the keyboard. For example, the ESC key could be assigned to a mouse button and this pushed when passing an LRP.

5.5.4 Screen Colours

The screen colours option defines the display mode for the program. The user can select no adapter, mono adapter or colour adapter. Since the system will generally be used with notebook computers, the mono adapter is the default (Option 2).

5.5.5 Remove Old Data

When a data file is moved to a floppy disk, a backup copy is maintained on the laptop with the extension .DB0. By selecting this option, all backup files older than a user specified date will be deleted.

5.5.6 User Defined Fields

ROMDAS has been defined to be a generic program which will meet the needs of most users. The standard data input screen contains sufficient fields for most needs. However, it is

© 2001Data Collections Ltd.

recognised that there are often additional data needs and this option will see additional optional fields created. Figure 5.18 shows the input screen for this option.

There are three user defined fields. These can be given any name and be up to 10 characters in length. The data may be:

X	Anything including punctuation marks
A	Alphanumeric
N	Numeric and punctuation marks
9	Numeric

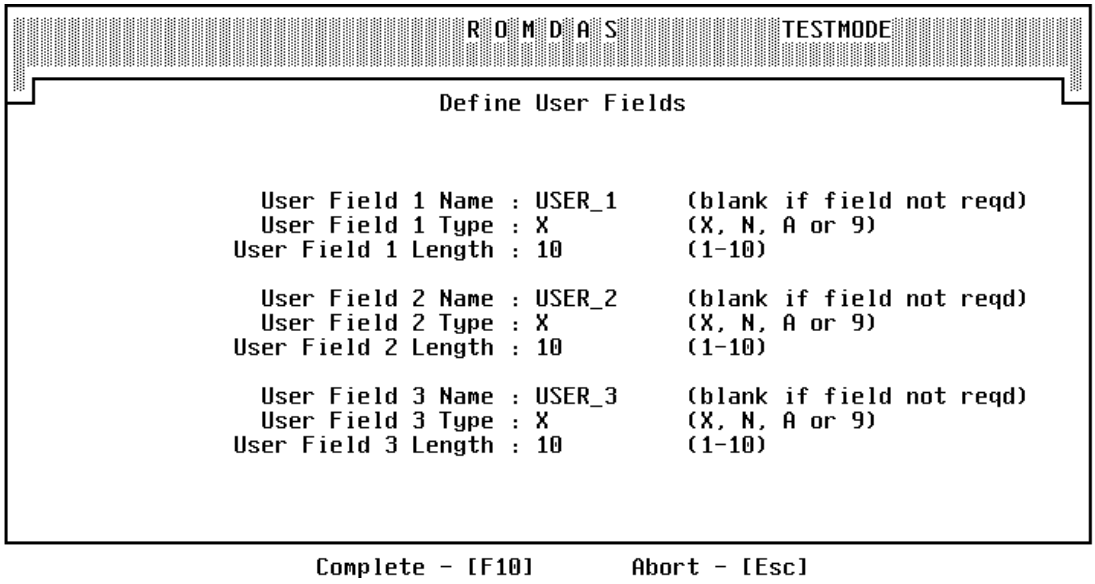

R O M D A S TESTMODE
Define User Fields
User Field 1 Name : USER_1 (blank if field not reqd)
User Field 1 Type : X (X, N, A or 9)
User Field 1 Length : 10 (1-10)
User Field 2 Name : USER_2 (blank if field not reqd)
User Field 2 Type : X (X, N, A or 9)
User Field 2 Length : 10 (1-10)
User Field 3 Name : USER_3 (blank if field not reqd)
User Field 3 Type : X (X, N, A or 9)
User Field 3 Length : 10 (1-10)
Complete - [F10] Abort - [Esc]

Figure 5.18: User Defined Fields

5.5.7 Custom Database Structures

It is possible for ROMDAS to output data in a format directly appropriate for importing into user's databases. This option leads to a menu item listing the databases which ROMDAS will currently output to and their customised structures.

The default database is dROAD, developed by Deighton & Associates of Canada[1]. This is one of the most powerful systems available for storing and manipulating road data.

The facility to export to other databases can be easily added to ROMDAS. Please contact DCL for details on customising it for your specific system. ANNEX L describes how the data are imported to the installed databases.

5.5.8 Time Date Setting

ROMDAS defaults to the current PC time and date. This can be altered either from the MS-DOS prompt or from this option. European style (DD/MM/YY) or American style (MM/DD/YY) formats can be selected.

[1] For information on dROAD contact Deighton Associates Ltd., 112 King Street East, Bowmanville, Ontario L1C 1N5, CANADA. Phone: 1-905-697-2644, FAX 1-905-697-2645, http://www.deighton.com.

© 2001Data Collections Ltd.

5.6 OPTIONS

The **OPTIONS** menu alters various important features of the ROMDAS program which are not commonly accessed. They will often be set by a survey manager and not the operators. Access to these options is therefore password protected. The initial password is **ROMDAS** and this should be changed by the end user. In the event that the new password is lost, the program will need to be reinstalled from the original master disk.

Figure 5.19 shows the menu options. The following sections discuss the contents of this menu in detail.

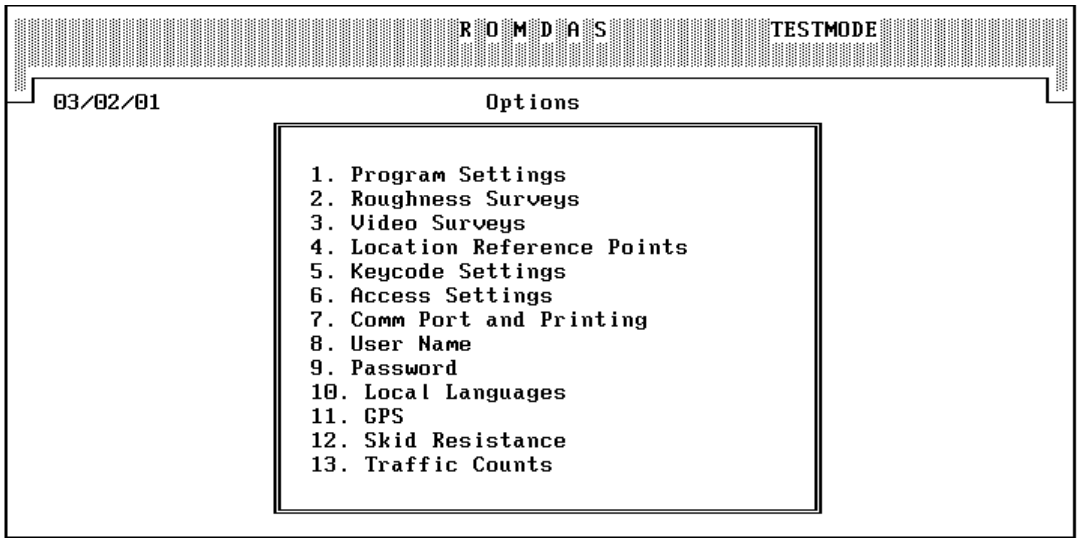


Figure 5.19: Options Menu

5.6.1 Program Settings

The **PROGRAM SETTINGS** menu gives access to general survey parameters (see Figure 5.20). The user sets the default values and options under this menu. When the survey is started these values will automatically be supplied. At that time they may then be overridden by the operator.

Use Proximity Sensor During Calibration

A proximity sensor (see ANNEX I) can be used to start and stop the recordings during a calibration of the odometer, roughness meter or the transverse profile logger. If this value is set to Y the system will look for a 12 v signal on the reverse light switch of the ROMDAS hardware interface to trigger the starting and stopping of the recording.

Minimum Speed

This is the minimum survey speed. If the average speed in the roughness survey over an interval drops below the minimum speed, the computer will beep at the end of the interval. The data file is flagged as having a speed below this level.

© 2001Data Collections Ltd.

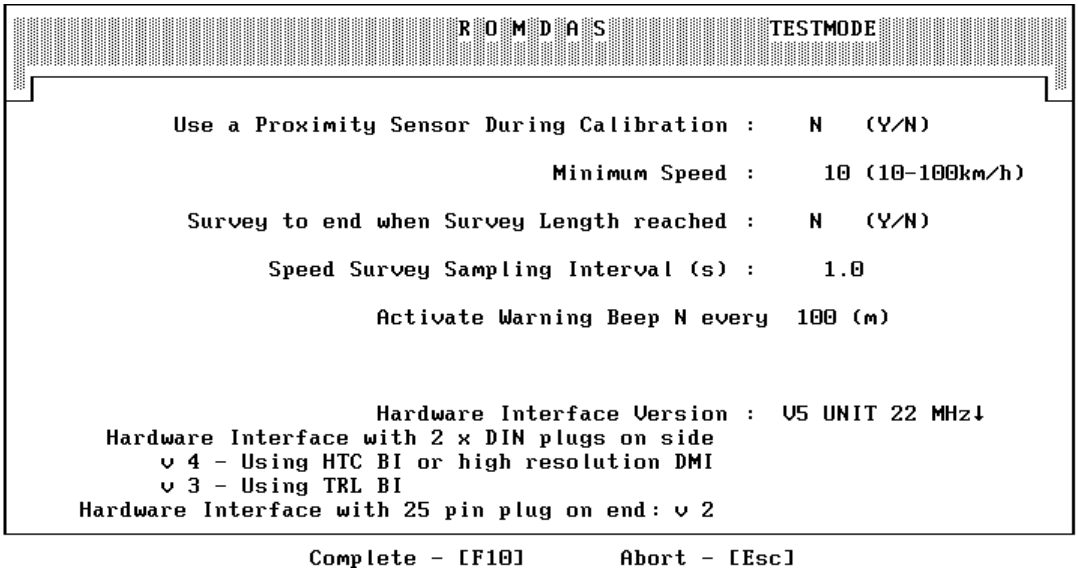

R O M D A S TESTMODE
Use a Proximity Sensor During Calibration : N (Y/N)
Minimum Speed : 10 (10-100km/h)
Survey to end when Survey Length reached : N (Y/N)
Speed Survey Sampling Interval (s) : 1.0
Activate Warning Beep N every 100 (m)
Hardware Interface Version : V5 UNIT 22 MHz↓
Hardware Interface with 2 x DIN plugs on side
v 4 - Using HTC BI or high resolution DMI
v 3 - Using TRL BI
Hardware Interface with 25 pin plug on end: v 2
Complete - [F10] Abort - [Esc]

Figure 5.20: Program Settings Menu

Survey to End when Survey Length Reached

When this option is selected the ROMDAS survey will automatically end when the user-defined survey length is reached. It is recommended that all surveys be ended manually so this option defaults to N.

Speed Survey Sampling Interval

The sampling interval (in s) when the speed survey data are updated. The lower the value the better.

Activate Warning Beep

This will see a beep activated at a regular interval instead of the default which is at the end of a sampling interval.

Hardware Interface Version

This is the version of the ROMDAS hardware interface. The versions are:

- Version 5 – Brown or Grey box with 3 DIN plugs on 2 sides, 1999 onwards.
- Version 4 – Blue box with 2 DIN plugs on side, 1998-99. This system works with the ROMDAS BI and the high resolution DMI;
- Version 3 – Box with 2 DIN plugs on side using TRL BI; or
- Version 2 – Silver box with 25 pin plug on end;

Since this option dictates the communication protocols, any incorrect version will render the system inoperable.

© 2001Data Collections Ltd.

5.6.2 Roughness Surveys

The **ROUGHNESS SURVEY** screen contains data primarily related to roughness surveys. Selecting this option gives the menu shown in Figure 5.21.

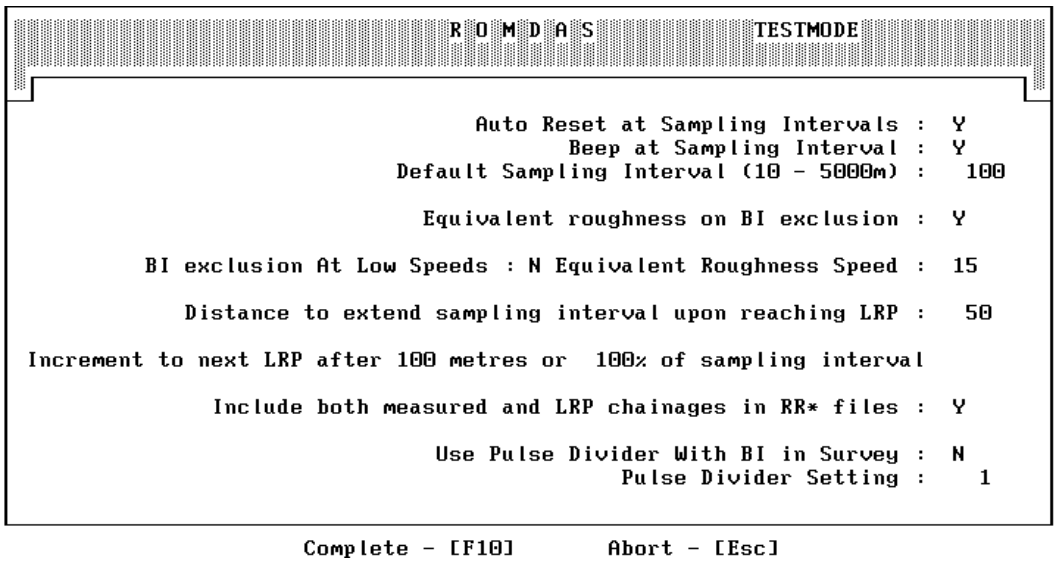

R O M D A S TESTMODE
Auto Reset at Sampling Intervals : Y
Beep at Sampling Interval : Y
Default Sampling Interval (10 - 5000m) : 100
Equivalent roughness on BI exclusion : Y
BI exclusion At Low Speeds : N Equivalent Roughness Speed : 15
Distance to extend sampling interval upon reaching LRP : 50
Increment to next LRP after 100 metres or 100% of sampling interval
Include both measured and LRP chainages in RR* files : Y
Use Pulse Divider With BI in Survey : N
Pulse Divider Setting : 1
Complete - [F10] Abort - [Esc]

Figure 5.21: Roughness Survey Settings

Auto-Reset at End of Sampling Interval

Normally, one defines a sampling interval for roughness surveys which is a fixed length (e.g. 100 m). The ROMDAS then automatically resets the roughness counts at the end of this sampling interval. However, if you wish to manually reset the roughness at the end of a sampling interval you would enter "N" here. The resets would then be done by pressing the ESC key (or the INSERT key if you were defining LRPs). In practice, this is only done with long sampling intervals, such as 1000 m, and is not normally recommended.

Beep at Sampling Interval

This option will have the ROMDAS system beep at the end of the roughness sampling interval.

Default Roughness Sampling Interval

The roughness sampling interval is the regular interval over which to sum the roughness counts.

It is recommended that 100 m be used for the minimum sampling interval, although if the vehicle is operating at 32 km/h 50 m intervals are possible. Even if data are only required at longer intervals, for example 1000 m, by sampling at short intervals the data can be aggregated upwards. However, if a large sampling interval is used the data cannot be disaggregated downwards. It is not recommended that intervals less than 50 m be used since, particularly on roads with low roughnesses, they can give misleading results.

© 2001Data Collections Ltd.

Equivalent Roughness on BI Exclusion

During a roughness survey the roughness meter can be temporarily halted. This is used, for example, when travelling over a road in the process of being reconstructed. It can be done either by halting the BI with a keycode event (see Section 5.3.1) or by pressing the F5 key (see Chapter 6).

If this option is selected as "Y" ROMDAS will calculate and record the equivalent roughness based on the length measured. Otherwise, ROMDAS will record the actual roughness (see Section 6.4).

BI Exclusion at Low Speeds

When this option is selected ROMDAS will automatically discard all measurements below the user specified speed and calculate the equivalent roughness. The user must define the speed below which this option is to be implemented.

Distance to Extend Sampling Interval At LRP

When approaching an LRP the situation may arise where the sampling interval may end just in advance of the point where the LRP reset is pressed. This would lead to a short section of data between the end of the sampling interval and the LRP. To avoid this, ROMDAS will extend the last sampling interval before the LRP by the distance specified here.

Distance After LRP Before Incrementing

This is the distance after an LRP before the program increments to the next LRP along the road. This feature allows for a delay in noting an LRP. The default setting is 100 per cent of the sampling interval.

It is recommended that this value be set to a multiple of the sampling interval since this greatly facilitates reconciling the data when there are missed LRPs.

Include/Replace LRP Chainages

The chainages of the LRPs should be baseline values against which all other measurements are referenced. During the roughness survey the vehicle is travelling at a speed and even a slight delay in pressing the LRP reset key will lead to an error in the chainage recorded. This option will use the LRP chainage from the LRP file to replace the chainage recorded by the vehicle.

By always replacing the recorded chainages with the LRP file chainages the data in successive surveys will always have the same start and end chainages. ROMDAS will automatically adjust the measurements to these chainages. This greatly facilitates importing the data into road management systems since the location referencing is the same for each section from year to year. For this reason this option defaults to "Y".

Pulse Divider

This option is used when the ROMDAS BI is used on a v3 or v2 interface. The pulse divider is an additional device placed between the BI and the ROMDAS to reduce the number of pulses coming into the system (required since the earlier hardware interfaces could not handle such

© 2001Data Collections Ltd.

a high rate of inputs). The number entered here is the divider setting. The raw data are multiplied by this number to convert them to the actual raw count.

5.6.3 Video Surveys

This menu contains data for the ROMDAS video system. A password **must** be used the first time the menu is accessed. This is provided only to those who have purchased the video system from DCL. Accessing this option gives the menu shown in Figure 5.22. The data are as follows.

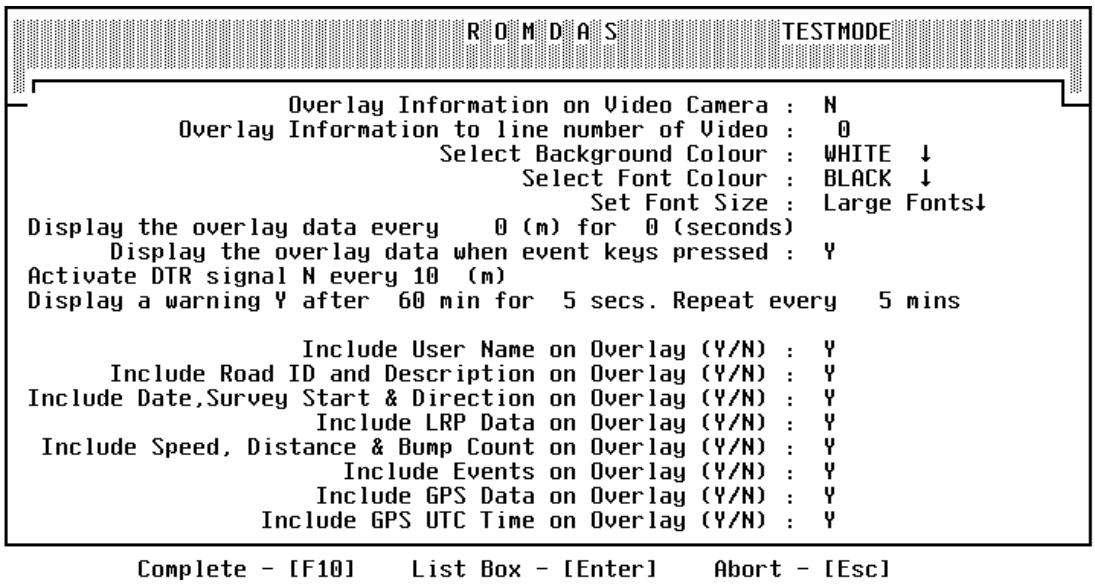

R O M D A S TESTMODE
Overlay Information on Video Camera : N
Overlay Information to line number of Video : 0
Select Background Colour : WHITE ↓
Select Font Colour : BLACK ↓
Set Font Size : Large Fonts↓
Display the overlay data every 0 (m) for 0 (seconds)
Display the overlay data when event keys pressed : Y
Activate DTR signal N every 10 (m)
Display a warning Y after 60 min for 5 secs. Repeat every 5 mins
Include User Name on Overlay (Y/N) : Y
Include Road ID and Description on Overlay (Y/N) : Y
Include Date,Survey Start & Direction on Overlay (Y/N) : Y
Include LRP Data on Overlay (Y/N) : Y
Include Speed, Distance & Bump Count on Overlay (Y/N) : Y
Include Events on Overlay (Y/N) : Y
Include GPS Data on Overlay (Y/N) : Y
Include GPS UTC Time on Overlay (Y/N) : Y
Complete - [F10] List Box - [Enter] Abort - [Esc]

Figure 5.22: Video Survey Settings

Overlay Information on Video Camera

This initialises the ROMDAS video camera reduced screen display option. When defined as Y the system will default to use the reduced display during surveys.

Screen Line to Display Video Data On

This entry defines where the overlaid video information will be displayed on the video. The data can be placed anywhere from the top to the bottom of the screen.

Select Background Colour

You can define the colour of the video overlay background. The most popular colour for the background is grey (with white letters).

Select Font Colour

You can define the colour of the fonts. The most popular colour is white (with grey background).

© 2001Data Collections Ltd.

Font Size

The overlay can have 'Large' or 'Small' fonts. The large fonts have less information but are easier to read so are the default.

Temporary Display of Overlay

In some applications it is important to have the overlay displayed only temporarily, for example when it is important to have the maximum viewable area on the video. This option will turn the overlay on at a fixed distance for a set period of time. It is also possible to turn the overlay on when a keycode event is pressed, again for a user definable period of time.

Activate DTR Signal

This option is used when there is to be real-time video capture. A special cable is used to connect the ROMDAS notebook to the video capture computer. The ROMDAS video capture software is used to trigger a capture at regular intervals along the road. This option must be set to 'Y' and the interval (in m) when captures are to be recorded defined.

Display Warning

This option displays a warning on the screen after the survey has been conducted for a certain period of time. It is used when direct digitising so as to ensure that the storage capacity of the digitising computer is not exceeded.

Data to Include on Overlay

The remaining options detail the data to be included on the overlay. They are provided so that the user can tailor the display to their exact needs. If the user name display option is activated the user name defined under **SETUP|OPTIONS|USER NAME** will be centred at the top of the video image.

If the data are not required, for example you are not collecting GPS data, set the entry to N otherwise a blank line will appear on the screen, needlessly reducing the viewable area.

5.6.4 Location Reference Points

Figure 5.23 shows the data defined using this menu option.

Default LRP Reset

This option defines whether or not to default to using LRPs. The options available are:

N	No LRPs
Y	Use LRPs
D	Add or define new LRPs

If you are defining LRPs (D), consider using the LRP Definition option (see Section 5.3.5). This allows you to define a short keycode associated with a longer description, making it easier to ensure consistency during the survey.

© 2001Data Collections Ltd.

Manual/Automatic LRP Resets

This option determines how LRP resets are to be recorded. Manual resets mean that the operator must press the ESC key; Automatic resets automatically reset the readings when the chainage corresponds to that of the LRP.

It is recommended that these resets be MANUAL (M) since there will always be slight differences in the chainages between surveys (see Chapter 2).

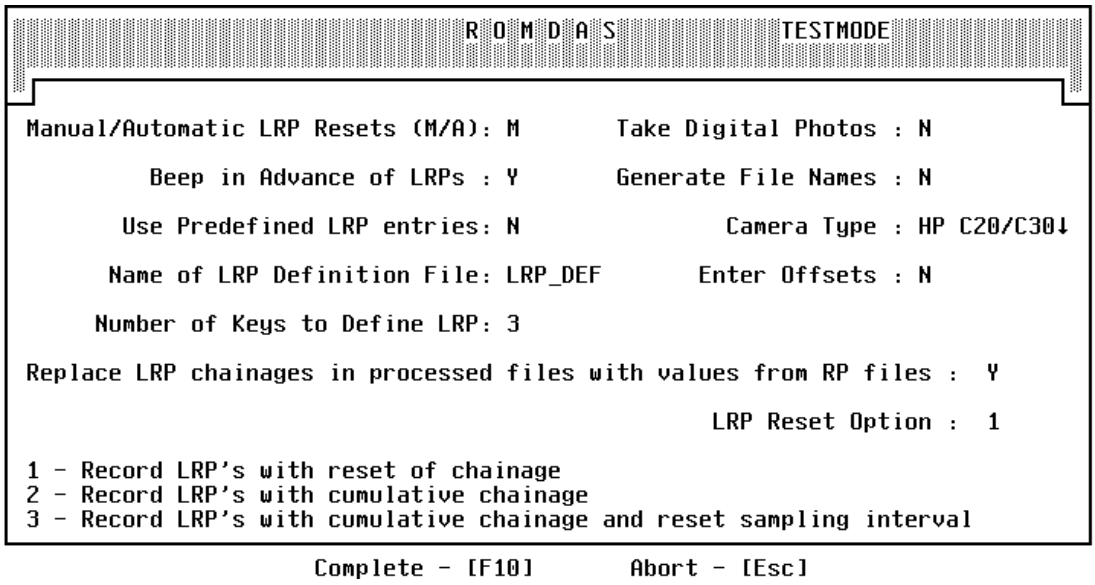

R O M D A S TESTMODE
Manual/Automatic LRP Resets (M/A): M
Take Digital Photos : N
Beep in Advance of LRPs : Y
Generate File Names : N
Use Predefined LRP entries: N
Camera Type : HP C20/C30↓
Name of LRP Definition File: LRP_DEF
Enter Offsets : N
Number of Keys to Define LRP: 3
Replace LRP chainages in processed files with values from RP files : Y
LRP Reset Option : 1
1 - Record LRP's with reset of chainage
2 - Record LRP's with cumulative chainage
3 - Record LRP's with cumulative chainage and reset sampling interval
Complete - [F10]
Abort - [Esc]

Figure 5.23: Location Reference Point Options

Beep in Advance of LRP

Setting this to "Y" warns the operator through audible beeps that an LRP is approaching. Beeps are given every 25 m before an LRP, starting at 100 m. It is recommended that this be enabled.

Use Predefined LRP Entries

As described in Section 5.3.5, it is possible to predefine the LRP descriptions. This means that during the survey the operators only need to enter a short code to identify the full entry. Setting this option to Y means that these definitions will be used when the ALT key is pressed during the survey.

Name of LRP Definition File

The default file name is LRP_DEF. This can be changed by entering another file name.

Number of Keys to Define LRP

This defines the number of keys used in the LRP Definition file as the code for the LRPs. Values can range from 2 to 6.

© 2001Data Collections Ltd.

Take Digital Photos

This option is used to assign digital photo numbers to specific LRPs. In the survey the vehicle will stop adjacent to the LRP and take a photo with a digital camera. Upon noting an LRP the operator will record the LRP data as in the standard survey. If this option is selected they will be asked to enter the digital photo number and, optionally, an offset (in m) from the vehicle to the LRP. This represents how far the LRP is off the road. The photo number is not automatically incremented since it is sometimes necessary to take multiple photographs.

Digital cameras have numbering systems which assign a unique identifier to each frame in the camera. The user can select the type of camera from the drop down list and ROMDAS will assign this nomenclature to each photo. If your camera is not included please provide us with details and we will customise the system accordingly.

For example, the HP C20/C30 system uses the year/month/date and photo number as its system. For example, photo 1 taken on 11 November 1999 would be associated with the file name: 991110-001.jpg.

LRP Reset Options

When LRPs are used in a survey there are three options for the chainages:

(1)	Reset Chainage:	The sampling interval is reset and the chainage is reset to 0.
(2)	Cumulative Chainage:	The total offset from the start of the survey is recorded.
(3)	Cumulative and Reset:	The sampling interval is reset but the chainage is not.

It is **STRONGLY** recommended that the chainage be reset (Option 1) when using LRPs since it limits errors in chainage measurements accumulating over a long survey. The rationale behind this was illustrated in Figure 2.1.

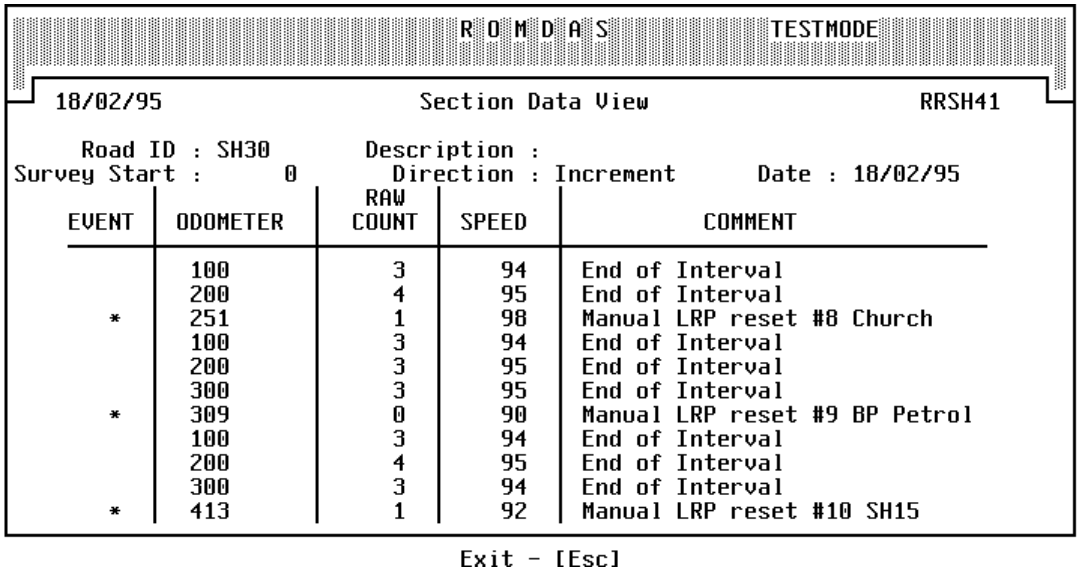
The following three figures illustrate the differences that arise with these three different options. The data were established using the 'Test' option of ROMDAS and are only for illustrative purposes.

Figure 5.24 shows a ROMDAS test run with the chainage reset at each LRP. Here, the 100 m roughness sampling intervals begin anew after each LRP but with the chainage reset to 0.

Figure 5.25 is an example of the output recording the cumulative chainage. It can be observed that the odometer readings increase continually from 0 chainage. Figure 5.26 shows the same data where the 100 m sampling intervals recommence after each LRP but with the cumulative chainage being recorded instead of being reset to 0.

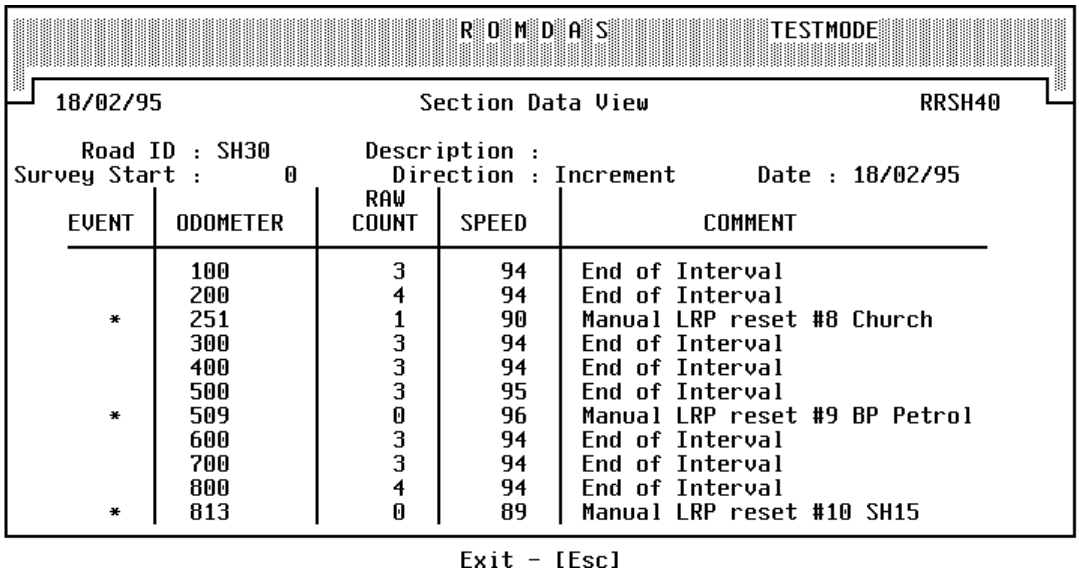
NOTE: When using the LRP reset option the bump count is always reset to 0 after an LRP.

© 2001Data Collections Ltd.



```
                    R O M D A S                    TESTMODE

 18/02/95                  Section Data View                  RRSH41

     Road ID : SH30        Description :
Survey Start :      0        Direction : Increment      Date : 18/02/95

                              RAW
   EVENT   ODOMETER          COUNT   SPEED          COMMENT
  ------------------------------------------------------------------
           100                3       94    End of Interval
           200                4       95    End of Interval
       *   251                1       98    Manual LRP reset #8 Church
           100                3       94    End of Interval
           200                3       95    End of Interval
           300                3       95    End of Interval
       *   309                0       90    Manual LRP reset #9 BP Petrol
           100                3       94    End of Interval
           200                4       95    End of Interval
           300                3       94    End of Interval
       *   413                1       92    Manual LRP reset #10 SH15

                          Exit - [Esc]
```

Figure 5.24: Example of Survey With Reset Chainage



```
                    R O M D A S                    TESTMODE

 18/02/95                  Section Data View                  RRSH40

     Road ID : SH30        Description :
Survey Start :      0        Direction : Increment      Date : 18/02/95

                              RAW
   EVENT   ODOMETER          COUNT   SPEED          COMMENT
  ------------------------------------------------------------------
           100                3       94    End of Interval
           200                4       94    End of Interval
       *   251                1       90    Manual LRP reset #8 Church
           300                3       94    End of Interval
           400                3       94    End of Interval
           500                3       95    End of Interval
       *   509                0       96    Manual LRP reset #9 BP Petrol
           600                3       94    End of Interval
           700                3       94    End of Interval
           800                4       94    End of Interval
       *   813                0       89    Manual LRP reset #10 SH15

                          Exit - [Esc]
```

Figure 5.25: Example of Survey With Cumulative Chainage

© 2001Data Collections Ltd.

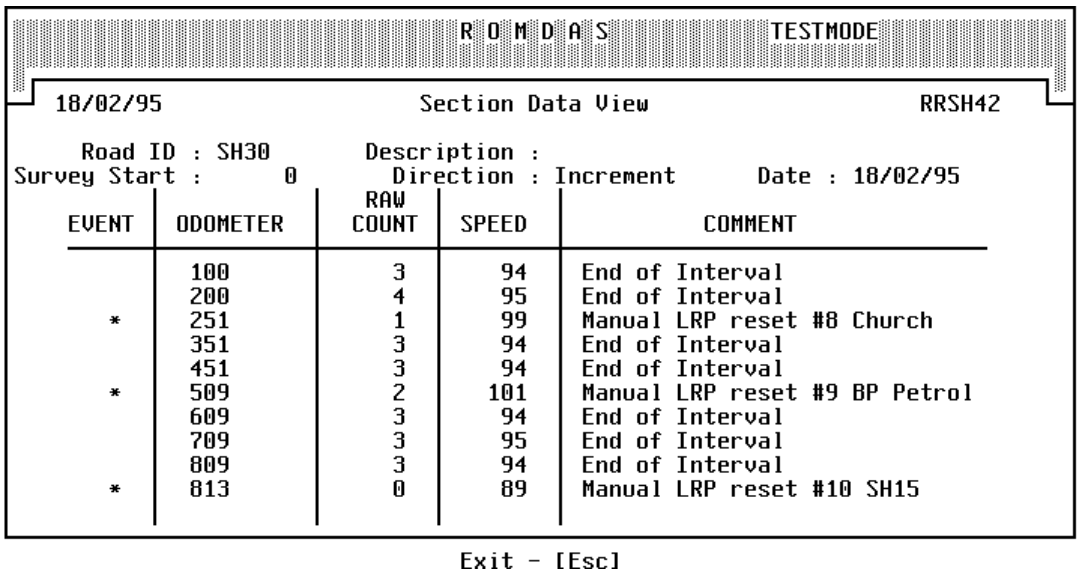

R O M D A S TESTMODE
18/02/95 Section Data View RRSH42
Road ID : SH30 Description :
Survey Start : 0 Direction : Increment Date : 18/02/95
EVENT | ODOMETER | RAW COUNT | SPEED | COMMENT
100 3 94 End of Interval
200 4 95 End of Interval
* 251 1 99 Manual LRP reset #8 Church
351 3 94 End of Interval
451 3 94 End of Interval
* 509 2 101 Manual LRP reset #9 BP Petrol
609 3 94 End of Interval
709 3 95 End of Interval
809 3 94 End of Interval
* 813 0 89 Manual LRP reset #10 SH15
Exit - [Esc]

Figure 5.26: Example of Survey with Cumulative Chainage and Reset

5.6.5 Keycode Settings

The Keycode Settings menu is used to define options for use in keycode rating.

Keycode Button Delay

This is the time delay (in s) for pressing a keycode event key twice. It is used to prevent incorrect readings due to the same key being pressed twice by mistake.

Number of Keycodes

It is possible to have 61 or 119 keycode events defined. For most applications 61 is more than sufficient so this is the system's default. If additional keycode events are required this option should be set to Y.

Second Push of Switch Event

Switch events are usually used to apply a condition rating which applies to all sections of road. Thus, if the condition is being rated from 0 to 5 it must always have a value, even if it is 0. Under certain situations users may wish to have sections of road not assigned any value. In this instance this option should be set to Y.

5.6.6 Access Settings

Figure 5.27 presents the Access Settings menu. This dictates the level of access which the operator will have to the data. These settings default to 'N'.

© 2001Data Collections Ltd.

Box 5.2 Important Advice

ROMDAS has been developed based on the input of several individuals with many years of experience in road condition monitoring surveys. On the basis of this experience ROMDAS has been designed to minimise the problems that occur with surveys. Because of this, we emphasise the following:

(1) **ALWAYS** use LRPs in your surveys. This will ensure that the data are related to permanent features at frequent intervals along the road. It is best to establish the LRPs in a separate survey to the roughness/condition survey. This is because in an LRP survey it may be necessary to stop the vehicle, back track, etc. which is not possible during a roughness survey.

(2) **NEVER** start a survey at one end of the road and drive to the other end without recording intermediate LRPs. This is a recipe for disaster.

(3) **ALWAYS** reset the chainage at the LRP. This will minimise cumulative errors in the odometer and make it easy to relate the results from surveys in different years. Many agencies expend a great deal of energy trying to "rubber-band" their data and reconcile surveys in successive years. By resetting the chainage at the LRPs you will be recording the offset from a permanent marker at regular intervals. This will minimise problems reconciling successive surveys (see Chapter 2).

(4) **ALWAYS** replace the measured LRP chainage in the files with the chainage from the LRP file. This again ensures consistency between surveys.

It is **NOT** recommend that you use the cumulative chainages, particularly without resets. This option has only been included in ROMDAS at the request of some users who want to continue with their existing practices.

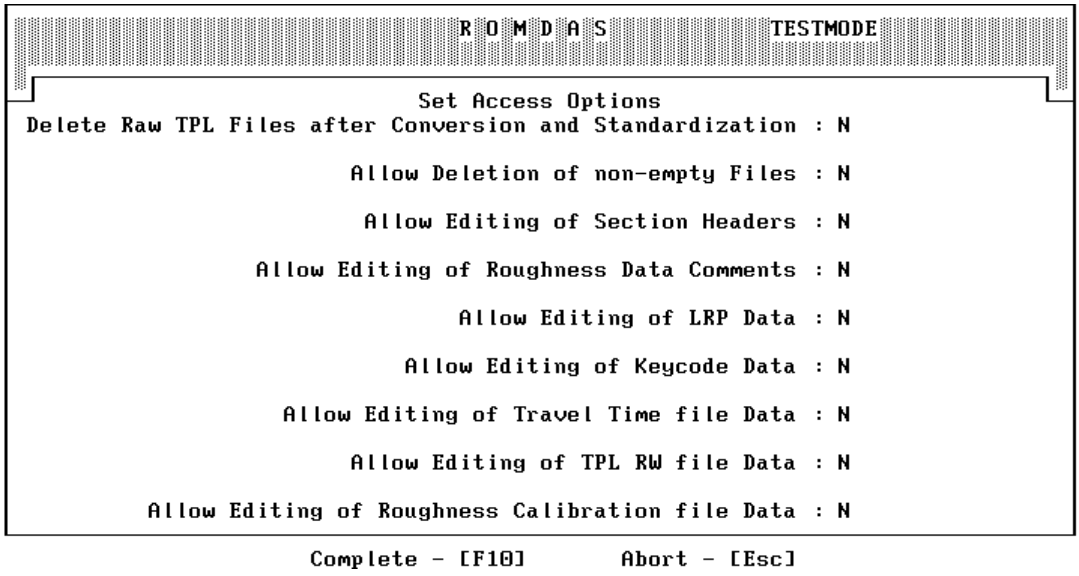

R O M D A S TESTMODE
Set Access Options
Delete Raw TPL Files after Conversion and Standardization : N
Allow Deletion of non-empty Files : N
Allow Editing of Section Headers : N
Allow Editing of Roughness Data Comments : N
Allow Editing of LRP Data : N
Allow Editing of Keycode Data : N
Allow Editing of Travel Time file Data : N
Allow Editing of TPL RW file Data : N
Allow Editing of Roughness Calibration file Data : N
Complete - [F10] Abort - [Esc]

Figure 5.27: Access Settings Menu

© 2001Data Collections Ltd.

Delete Raw TPL Files after Conversion and Standardisation

Once the Transverse Profile Logger data have been downloaded, it must be converted and standardised (see Section 11.3). By setting the value here to Y the original files will be deleted. This practice is **NOT** recommended.

Allow Deletion of non-empty Files

This allows the user delete files which may have data in them. If it is selected as N, the user will only be able to delete files which are empty.

Allow Editing of Section Headers

After a survey is completed, the user may wish to alter from within ROMDAS the Section Headers due to the data being incorrectly specified. This can only be done if this option is specified as Y.

Allow Editing of Roughness Data Comments

The ROMDAS roughness data (RRxxxxxx.DBF) file contains a field which has comments on the event corresponding to each record. If "Y" is selected here, the operator will be able to manually alter these comments.

Allow Editing of LRP Data

This option allows the operator to edit the LRP data files (RPxxxxxx.DBF). Any data in the files can be edited.

Allow Editing of Keycode Data

This option allows the operator to edit the keycode data files (RKxxxxxx.DBF). Any data in the files can be edited.

Allow Editing of Travel Time Data

This option allows the operator to edit the travel time data files (RTxxxxxx.DBF). Any data in the files can be edited.

Allow Editing of TPL RW Data

This option will allow the operator to edit the TPL data which has been standardised and converted.

5.6.7 COMM Port and Printing

There are two menu items for COMM Port and Printing: the standard settings an advanced settings. Standard settings are what most users will use and Figure 5.28 shows the data entry for this option.

This defines the COMM ports that the system will communicate through. The software can run on COMM ports 1 to 4. The default settings are:

© 2001Data Collections Ltd.

ROMDAS Hardware Interface	COM 1
Transverse Profile Logger	COM 2
Skid Resistance	COM 2
GPS 1	COM 2
GPS 2	COM 3
Laser Surveyor	COM 4

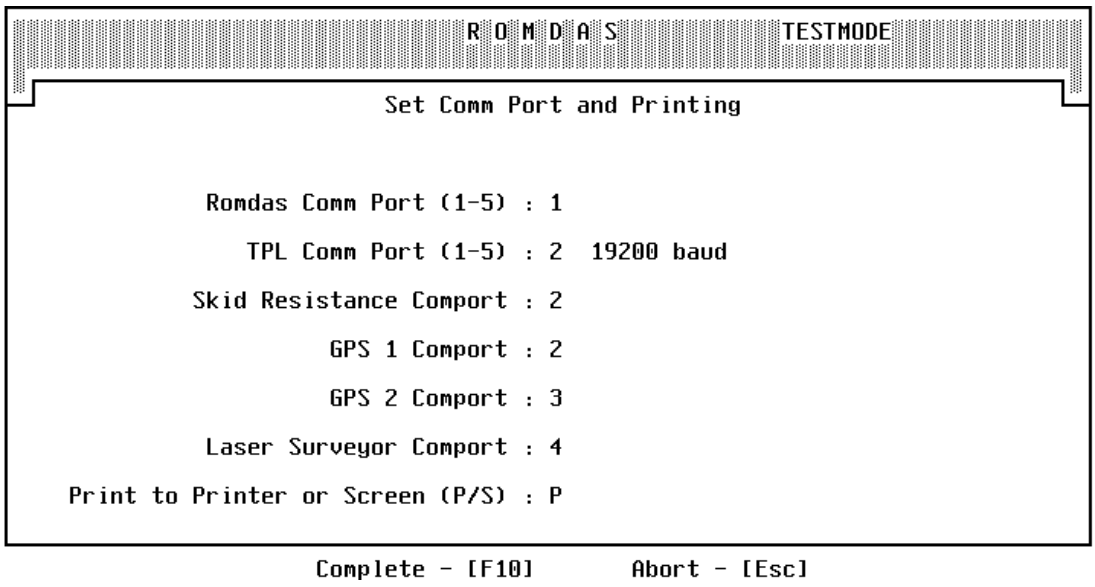

R O M D A S TESTMODE
Set Comm Port and Printing
Romdas Comm Port (1-5) : 1
TPL Comm Port (1-5) : 2 19200 baud
Skid Resistance Comport : 2
GPS 1 Comport : 2
GPS 2 Comport : 3
Laser Surveyor Comport : 4
Print to Printer or Screen (P/S) : P
Complete - [F10] Abort - [Esc]

Figure 5.28: Standard COM Port Settings

All instruments must be on different ports.

This menu also sets the baud rate for the TPL data download. For the v 1 TPL the baud rate is 9600; for the v 2 (default) it is 19200.

The printing of reports etc. is normally done to the printer, however, by entering S here they will instead be displayed to the screen.

Advanced settings are used when there are additional COMM ports installed to a computer, for example using PCMCIA cards. This gives the HEX port address and the IRQ values. **DO NOT** change these unless you know what you are doing. ANNEX R describes how these devices are installed with some devices.

5.6.8 User Name

This option allows the user to alter the licensee name which is displayed on start up and optionally superimposed on the ROMDAS video.

5.6.9 Password Setting

This option resets the password which allows access to the Setup options. It defaults to **ROMDAS** and this should be changed by the manager of the surveys.

© 2001Data Collections Ltd.

5.6.10 Local Languages

ROMDAS allows the user to replace the English menus with menus in their own local languages. The text of all menus are stored as data items. The user can select a menu and replace the text with the local language. This information is stored in the file MSGLOCAL.DBF, with the original English languages as MSGENGL.DBF. The only constraint will be that the local menus will need to be the same length, or shorter, than the English menus.

Figure 5.29 shows the screen containing some of the English menus. Selecting an entry and pressing ENTER opens an editing screen. The message should then be replaced by one in the local language (Roman alphabet only).

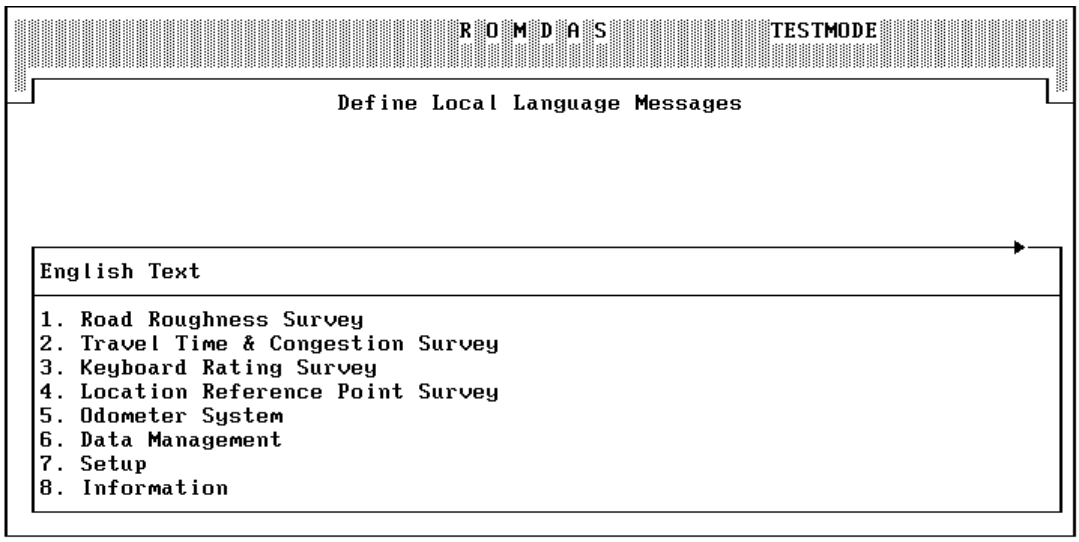


Figure 5.29: Local Language Definition

5.6.11 GPS

The GPS menu provides access to four options:

- GPS Setup Menu
- GPS Process Menu
- GPS NMEA Test Menu
- Log GPS Data

GPS Setup Menu

This menu provides access to specify the GPS survey equipment. It is password protected and can only be accessed if this option has been activated by DCL (unless the system is running in 'Test Mode'). Figure 5.30 shows the contents of this menu.

The system can log from two different receivers. GPS 1 is common to all users. It is usually a NMEA compliant receiver which transmits serial data. Examples of this are receivers such as the Trimble Pro-XRS or the OmniStar System which gives real time differential GPS corrections through its proprietary network. The system also supports the Rockwell NAVCARD receiver which is a PCMCIA card.

© 2001Data Collections Ltd.

GPS 2 is used for gyroscope data. These are required when there is a loss of satellite lock on GPS 1, for example when driving between high buildings. As shown in Section 13.5, the data from GPS 2 are used to estimate the missing positions.

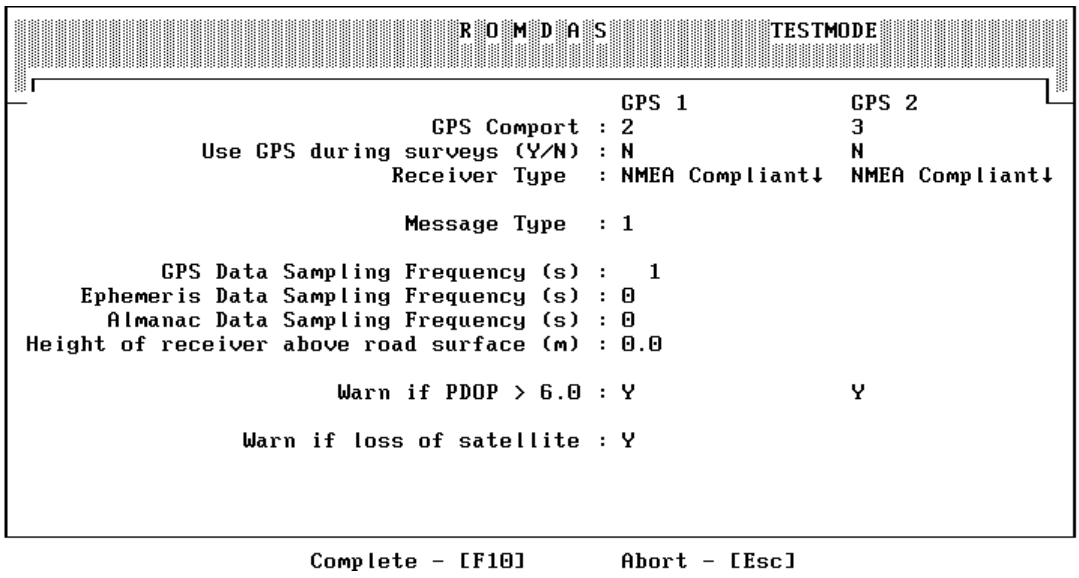

R O M D A S TESTMODE
GPS 1 GPS 2
GPS Comport : 2 3
Use GPS during surveys (Y/N) : N N
Receiver Type : NMEA Compliant↓ NMEA Compliant↓
Message Type : 1
GPS Data Sampling Frequency (s) : 1
Ephemeris Data Sampling Frequency (s) : 0
Almanac Data Sampling Frequency (s) : 0
Height of receiver above road surface (m) : 0.0
Warn if PDOP > 6.0 : Y Y
Warn if loss of satellite : Y
Complete - [F10] Abort - [Esc]

Figure 5.30: GPS Setup Options

The key entries that are required are:

- **Use GPS During Surveys**. Set to Y if you plan on using a GPS receiver.
- **Receiver Type**. Set to NMEA compliant and ensure that the GPS receiver is set to have NMEA compliant output.
- **GPS Sampling Frequency**. This is how frequent ROMDAS samples the GPS data. It is usually set to 1 s.
- **Height of Receiver Above Road**. This is the height of the receiver antenna above the road surface. This value is subtracted from the GPS height to get the height of the road.
- **Warn if PDOP >**. When a value is defined here a warning will be displayed when there is a loss of precision (see Chapter 13 for a discussion of PDOP values).
- **Warn if Loss of Satellite**. This option will display a warning if there is a loss of satellite.

GPS Process Menu

The GPS process menu contains the options applied during the processing of the GPS data. It is important that these be carefully considered as they will have a major impact on the processed output.

- **Convert GPS to Decimal Degrees**. By default ROMDAS stores the data as northings and eastings. This will convert the data to decimal degrees.
- **Eliminate Duplicate GPS Readings**. If the GPS sampling is set to an interval of once per second, there can be duplicate chainages with the same GPS data due to the speed of the vehicle. This option will delete the second reading as the first is always the correct GPS co-ordinate for that chainage.
- **Average GPS Readings When Stopped at an LRP**. When a vehicle is stopped at an LRP there can be a series of GPS readings. This option will see them averaged

© 2001Data Collections Ltd.

and a single value supplied for the LRP. If not selected, the first reading will be used.

- **Estimate Data from GPS 2**. This estimates missing or poor PDOP data from the gyroscope data. Set to Y if a gyroscope is installed.
- **Replace Survey Data with Post Processed Data**. If you are supplying a file with post-processed, differentially corrected data, set this option to Y. This will see the ROMDAS GPS data replaced with the corresponding differentially corrected data.
- **Difference Between Local and UTC Time Code**. This is the difference in the time stamps in the differentially corrected data from the UTC time stored by ROMDAS. If the differentially corrected data have the UTC times the values should be set to 0.
- **Interpolate Chainages From Post Processed Data**. Sometimes there are post-processed co-ordinates for which there are no corresponding ROMDAS chainages. This option interpolates the chainages from these values.

GPS NMEA Test Menu

If you are using a receiver which is connected to a communications port there may be problems in getting ROMDAS and the GPS to talk to one another. This menu item will display the data received by ROMDAS. If the data are not displayed, this is invariably due to incorrect communications parameters being set or that the receiver is not actually transmitting.

To confirm that the parameters are correctly set and the receiver is transmitting you can use a standard terminal program such as Hyperterminal which comes with Windows 95. The procedure for setting up Hyperterminal is as follows:

- Start Hypeterminal. In the first box there is a dialog box entitled 'Connection Description'. Enter GPS in the 'Name' field and press OK.
- You will be presented with a dialog box entitled 'Phone Number'. Instead of entering a phone number from the drop down list at the bottom of the box entitled 'Connect using' select the COM port the GPS receiver is connected to (*e.g.* 'Direct to COM 1').
- You will then be presented with the port settings. Set all the fields to match your receiver and set the 'Flow control' to NONE. Hit OK.

At this point if the GPS receiver is transmitting correctly you will have an NMEA or similar string such as:

```
$GPGGA,012338.61,5619.2837,N,17235.8964,E,1,05,02.3,- 00034.2,M,,M,,*66.
```

If the string is illegible this means the communications settings are incorrect. Try resetting the BAUD rate since this often solves the problem. Once you have confirmed that the GPS is transmitting and what the appropriate baud rate settings are you should return to ROMDAS and set it up with those values.

Log GPS Data

This option will log the data directly to the ROMDAS RG******.DBF file without having to run a survey. It is useful for diagnostics and debugging.

5.6.12 Skid Resistance

ROMDAS will collect skid resistance data at the same time as the other survey instruments. It is currently designed to work with the Findlay Irvine GripTester, but will work with any other skid resistance device which has a serial protocol.

© 2001Data Collections Ltd.

Figure 5.31 shows the data input screen for the GripTester. It is password protected and can only be accessed if this option has been activated by DCL (unless the system is running in 'Test Mode').

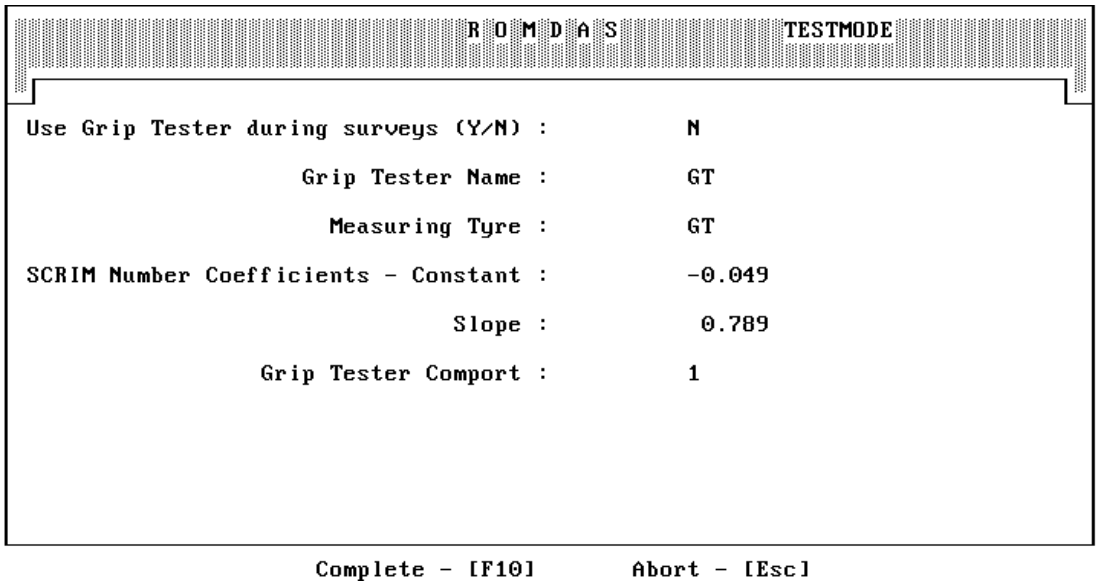

R O M D A S TESTMODE
Use Grip Tester during surveys (Y/N) : N
Grip Tester Name : GT
Measuring Tyre : GT
SCRIM Number Coefficients - Constant : -0.049
Slope : 0.789
Grip Tester Comport : 1
Complete - [F10] Abort - [Esc]

Figure 5.31: GripTester Data Input Screen

If the entry to use the GripTester in surveys is set to 'Y' the operators will have the option of selecting the GripTester at the start of each survey run. The GripTester name and measuring tyre are recorded and stored in the header file from the survey. The SCRIM coefficients are used to convert the Grip Number to a SCRIM number. The GripTester comport number is given for illustrative purposes only; it is defined along with the comport numbers for the other instruments as described in Section 5.6.7.

5.6.13 Moving Traffic Surveys

This menu is used to define the moving traffic survey data. Moving traffic surveys are described in detail in Chapter 15. Selecting this option gives the menu illustrated in Figure 5.32.

The first five entries pertain to the ROMDAS automatic traffic counting system. This is currently under development and when affixed to the side of the vehicle it will automatically record when a vehicle is passed. With Version 1 the user will have the option of manually classifying the vehicle; a future version will automatically classify the vehicle based on length.

The most important data item is the data processing method. The ROMDAS method is presented in Chapter 15. This uses the relative speed of different vehicles to improve upon the ADT estimate. The TRL method corrects for vehicles overtaking and overtaken. The ROMDAS method is the default method.

When using the ROMDAS method the speed of the opposing vehicles is important. This is set to 0 as the default which means that the survey vehicle is assumed to travel at the same mean speed as the opposing vehicles.

© 2001Data Collections Ltd.

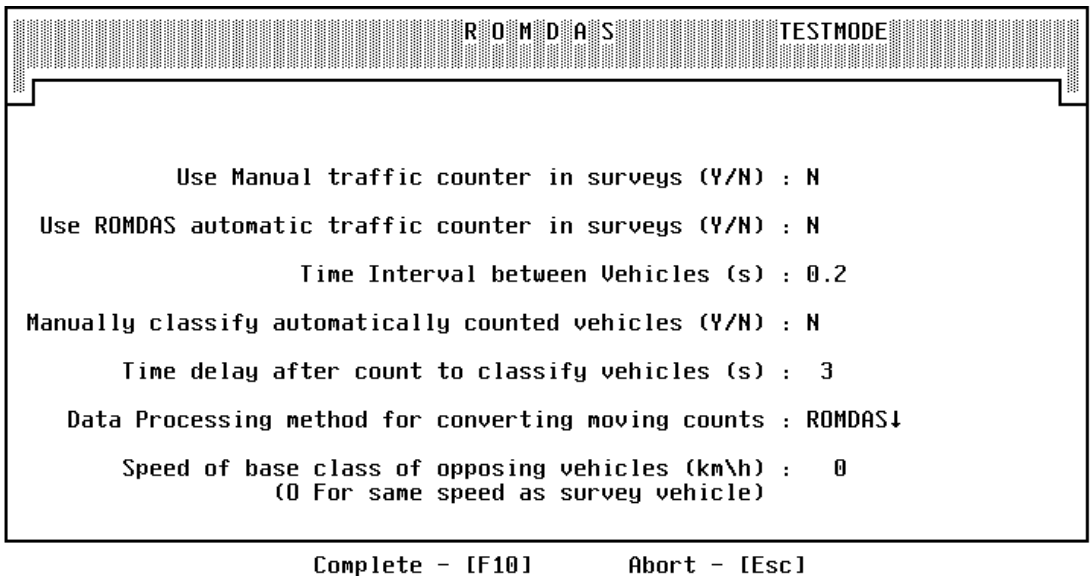

R O M D A S TESTMODE
Use Manual traffic counter in surveys (Y/N) : N
Use ROMDAS automatic traffic counter in surveys (Y/N) : N
Time Interval between Vehicles (s) : 0.2
Manually classify automatically counted vehicles (Y/N) : N
Time delay after count to classify vehicles (s) : 3
Data Processing method for converting moving counts : ROMDAS↓
Speed of base class of opposing vehicles (km\h) : 0
(0 For same speed as survey vehicle)
Complete - [F10] Abort - [Esc]

Figure 5.32: Moving Traffic Survey Data

5.6.14 Laser Surveyor

The ROMDAS Laser Surveyor is used during surveys to record the location of roadside events, such as km stones or traffic signs. It consists of a hand-held laser gun with an inclinometer and directional compass. The system returns the distance, angle and direction of the object from the ROMDAS vehicle. Figure 5.33 shows the data entry for the Laser Surveyor. This is accessed via a password protected menu and is available only to those who have paid for the Laser Surveyor option.

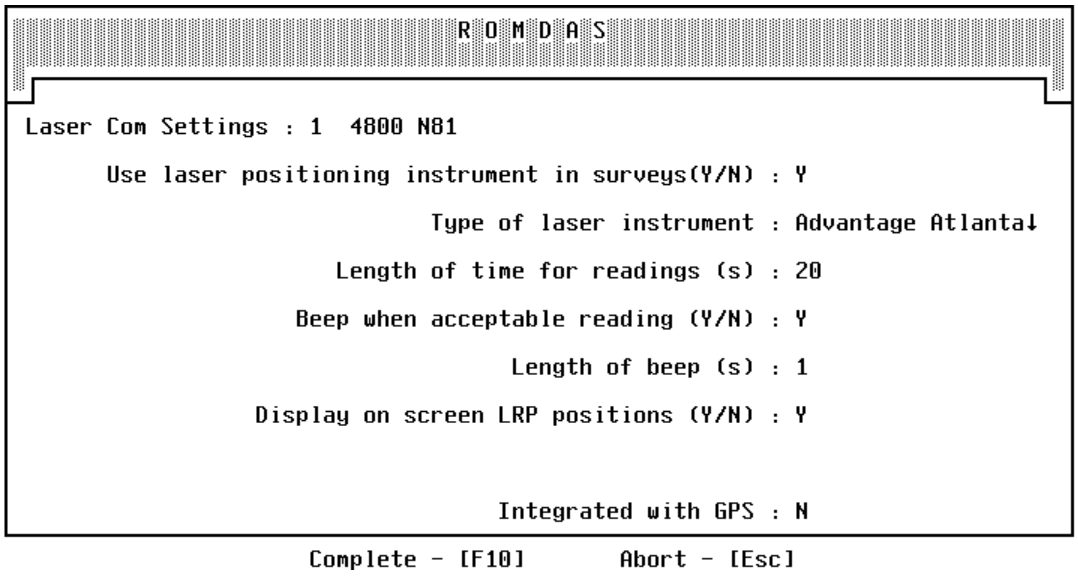

R O M D A S
Laser Com Settings : 1 4800 N81
Use laser positioning instrument in surveys(Y/N) : Y
Type of laser instrument : Advantage Atlanta↓
Length of time for readings (s) : 20
Beep when acceptable reading (Y/N) : Y
Length of beep (s) : 1
Display on screen LRP positions (Y/N) : Y
Integrated with GPS : N
Complete - [F10] Abort - [Esc]

Figure 5.33: Laser Surveyor Data Entry System

© 2001Data Collections Ltd.

User Laser Surveyor

This option must be set to Y (yes) for the system to work.

Type of Laser Instrument

You must specify the type of laser instrument to be used. The system is currently setup for the Laser Atlanta and Laser Technology instruments.

Length of Time for Readings

The length of time in s for to monitor for readings once the data are received.

Beep When Acceptable Reading and Length of Beep

Whether the ROMDAS computer should beep and for how long the beep should play.

Display on Screen with LRPs

When this option is selected the laser data will be displayed on the screen once a fix is made.

Integrated With GPS

Whether the instrument will return the GPS co-ordinates of the object. For this to work the instrument must be integrated with a GPS.

© 2001Data Collections Ltd.

6. ROAD ROUGHNESS SURVEYS

6.1 INTRODUCTION

Road roughness surveys are used to record:

- road roughness;
- keyboard events;
- define new location reference points;
- conduct moving traffic surveys;
- transverse profile measurements—if a transverse profile logger is installed;
- GPS data—if a GPS receiver is installed;
- skid resistance—if a skid resistance device such as the GripTester is installed.

The recording of keyboard events, location reference points and transverse profile measurements are optional.

ANNEX N has step-by-step instructions to running a roughness survey.

Box 6.1 Roughness Display

By default ROMDAS displays the raw roughness. If you would like to have a calibrated roughness displayed you must define the coefficients as described in Section 5.3.3.

6.2 PREPARING FOR THE SURVEY

Before starting a roughness survey ensure that the following has been done:

- the odometer has been calibrated with the tyres balanced and at a standard pressure;
- the tyres on the vehicle should be at the same pressure as when the odometer calibration was performed. This should be checked at the start of each day during the survey[1];
- spare fuses for the ROMDAS, spare roughness sensor, and wire cables for the roughness meter, should be on hand;
- if the survey is a repeat of a previous survey on the same section of road, the chainages of the LRPs should be known and in a data file.

Each day, it is important that the vehicle be checked. The following page contains an example of a form which was used in India with surveys with roughness and videos. Table 6.1 shows the survey instructions prepared by Kinhill Pty. Ltd. of Australia for the Tamil Nadu PCC project in India. The ROMDAS Quality and Management Plan report which can be downloaded or is on the ROMDAS CD has a series of forms designe to assist with improving survey quality.

[1] As described in ANNEX J, the tyre pressure can be set with the tyres either warm or cold. As long as you are consistent it does not matter which.

© 2001Data Collections Ltd.

ROMDAS DAILY PRE-SURVEY CHECK LIST

Date	Tyre Pressure Set to Standard Pressure	Fuel Tank Full	ROMDAS Battery Recharged Overnight	ROMDAS Battery Connected	Bump Integrator Cable Checked	Video Camera Installed Securely with Lens Cleaned	Video Cables Connected and Set to Auto-Focus	Start Vehicle	Plug in Power Inverters and Check Power to Video and Computer	Turn on ROMDAS and Ensure Lights are On

© 2001Data Collections Ltd..

Table 6.1: ROMDAS Survey Instructions from India

Procedure for Conducting ROMDAS Roughness and Video Survey	
At Start of each Day	
1	Remove ROMDAS battery and place in engine position
2	Place engine battery in ROMDAS position
3	Drive to 100 m before section start point
4	Check and adjust tyre pressure to 30 psi
5	Check BI cable and fit onto axle hook
6	Check that camera viewing fields are correct
7	Check that camera mounting bolts are tight
At Start of Each Section	
8	Write section name onto new videotape and put into VCR
9	Switch ON Computer, ROMDAS, Inverter, Miniplex and VCR
10	Open ROMDAS roughness survey screen
11	Enter section name into computer (node/node eg 025046)
12	Enter file name as for section name (RB025046)
13	Enter description of section (Arcot to Ulundurpettai) and Tape Number
14	Press ENTER key to set computer for recording
15	Start VCR recording as Node intersection is entered
16	Press SPACE to start computer recording when leaving Node intersection
17	Press ESC as LRP's are passed
	Record description of end point Take photograph of end point for later crew recognition

6.3 DEFINING SURVEY DATA

Highlighting **ROAD ROUGHNESS SURVEY** at the ROMDAS opening menu gives the roughness survey definition screen. The user is prompted for a variety of data and then commences the survey. Figure 6.1 is an example of the input screen for this option.

There four groupings of data with the input screen:

- data describing the road to be surveyed;
- data on the LRPs
- data influencing how the survey is conducted;
- data on the survey operator and vehicle.

In the bottom row at the right the directory where the data will be stored is shown. This can be changed using the method described in Section 5.5.

The following defines the various data items required.

© 2001 Data Collection Ltd.

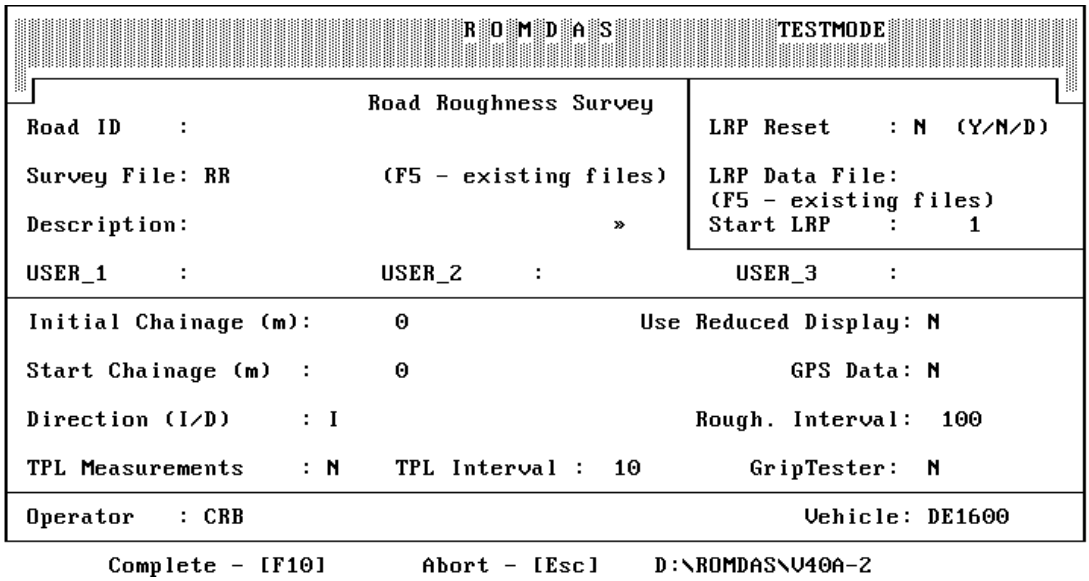


Figure 6.1: Roughness Survey Screen

Road ID

A 64 character identifier for the road. When the Road ID is entered, the software checks the file ROADDAT.DBF to see whether this road has survey data defined for it. If it does, the data are entered into the fields describing the data file, description, LRP reset, and LRP file fields. If it is not defined, the data entered into these fields are appended to the ROADDAT file. Section 17.11.4 describes the ROADDAT.DBF file.

Data File

This is the name of the file to store the data to for this survey. All ROMDAS raw roughness survey files have the letters RR as the first two letters In the name. Thus, because DOS only has 8 letter names, the operator may only supply a maximum of 6 letters. The name supplied must be unique. The resulting files will be given the extension names .DBF (RRxxxxxx.DBF).

NOTE: You cannot overwrite an existing file. Records can only be appended.

Description

A 64 character description of the road.

User Defined Fields

Figure 6.1 contains three fields called USER_1 to USER_3. These are the optional user defined fields defined as described in Section 5.5.6.

LRP Reset

There are 3 options for using location reference points:

© 2001 Data Collection Ltd.

- Enter a "Y" in this box if you have LRP data from a previous survey and you want to correlate the current survey to this previous data;
- Enter a "D" if you want to define your LRPs as you are conducting the roughness survey - these can be added to an existing file or stored in a new file;
- Enter "N" if you do not wish to use LRPs.

If you are defining LRPs during the survey (D), when you press the INSERT key a box will be presented where you can enter the LRP name. The system will store the name and the chainage in the LRP file.

Alternatively, as described in Section 5.3.5, you can create the file LRP_DEF which contains predefined LRP descriptions. For example, the file may have the number 100 and the LRP definition is "km Stone 100"; RXX for "Railway Crossing".

LRP Data File

This is the name of the file containing the LRP data from a previous survey (or the name of the existing/new file to store the data in if "D" defined as described above). The file name will default to having RP for the first two letters so the user may only supply a maximum of 6 letters. The name must be unique.

Start LRP

This is the number of the LRP to start the survey at. This feature allows you to start the survey at any point along a road which has a series of LRPs instead of just at the beginning.

Each LRP has three attributes: its number, its chainage and its description. The numbers increase continually from the start of the road and can be viewed along with the other attributes from the **DATA MANAGEMENT|LRP DATA|EDIT LRP DATA FILES** menu.

The user must enter the LRP number corresponding to the start point for the survey. The LRP file will be advanced to this point and upon starting the survey the next LRP will be the one following the start LRP.

Initial Chainage

The chainage along the road where the survey is starting. This will usually be 0. It would be non-zero if the survey starting part way along the road.

Start Chainage

The chainage where the survey should start. This will usually be 0. This option allows you to start driving at a known point and then commence the survey further along the road.

Direction (I/D)

This indicates if the measurements are increasing or decreasing. For example, a road section starting at 0 and going to 1000 m is increasing, with the other direction being classified as decreasing.

© 2001 Data Collection Ltd.

Use Reduced Display

The ROMDAS video option overlays 5 lines of data on the video. This reduced screen display is initiated through this entry. It must first be activated from the **SETUP|OPTIONS|VIDEO SURVEYS** menu (see Section 5.6.3).

GPS Data

If a GPS receiver is installed the GPS data will be recorded at the user defined sampling intervals (see Section 5.6.11).

Sampling Interval

This is the sampling interval for accumulating the roughness measurements, usually 100 m. It defaults to the value defined through the **SETUP|OPTIONS|ROUGHNESS SURVEYS** menu (see Section 5.6.2).

NOTE: A maximum of 4095 samples can be stored in one run.

TPL Measurements

If transverse profile measurements are to be made this value must be set to Y. The default value is set under the **SETUP|TPL|TPL SETUP** menu (see Section 5.4.2)

Transverse Profile Interval

The sampling interval for taking transverse profile measurements, usually 10 m (see Section 5.4.2). The TPL samples at a rate of 0.12 s so the minimum interval is a function of the vehicle speed. The 10 m interval is sufficient for most pavements. Chapter 11 describes the TPL and its operation.

NOTE: A maximum of 32768 samples can be stored before TPL data needs to be downloaded.

GripTester

If the GripTester is installed to collect skid resistance data it will be used to record the Grip Number at 10 m intervals (see Section 5.6.12).

Operator

This is the name of the ROMDAS operator. This is stored in the survey log file and the raw data file and is a required data item.

Vehicle

A 6 character survey vehicle identification number. This is a required data item and is used to ensure that the correct roughness calibration equations are used for converting the raw data. When the roughness calibration equations are defined, the user is asked to give the vehicle code that these equations apply to. Before analysing the data the program checks to ensure that the data and equations match the same vehicle. If they do not the user is given a warning.

© 2001 Data Collection Ltd.

Box 6.2 An Easier Way

Instead of entering the data as described above, you can create a "Road Description File" called ROADDAT.DBF. This file contains the Road ID, Description, LRP information as well as any user defined fields. When the operator enters the Road ID the other data are inserted into the appropriate fields. An example of the file is shown in ANNEX M.

The file is created as described in Section 5.3.4. The survey manager should create this file and provide it to the operators. This will ensure that the file names, LRP files and road descriptions are correctly applied/stored in the surveys.

If defining LRPs during a survey, the LRP Definition file (see Section 5.3.5) will ensure consistent definitions as well as simplifying the survey.

6.4 CONDUCTING A SURVEY

A survey is conducted by firstly preparing the vehicle and then defining the data required as outlined in Section 6.3 above. Once these data have been entered, the F10 key should be pressed. The vehicle is then ready for the survey.

In advance of the survey starting point, the vehicle should be driven to its survey speed. As the vehicle crosses the point marking the start of the survey the SPACE bar should be pressed to start the recording.

Figure 6.2 is an example of the normal display during a roughness survey. When using the ROMDAS video camera a reduced display is shown which only consists of 5 lines of essential data.

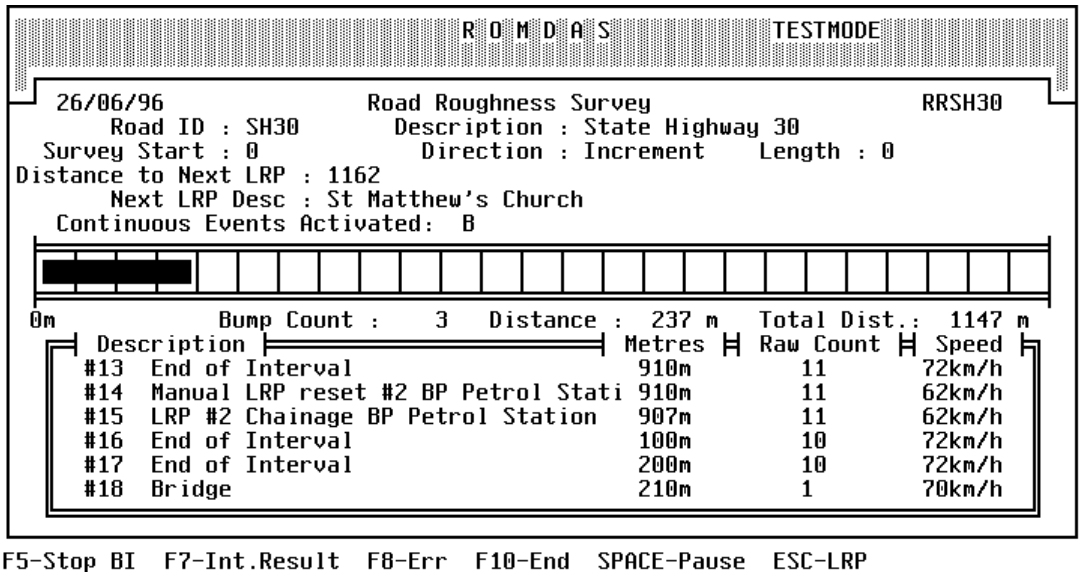

R O M D A S TESTMODE
26/06/96 Road Roughness Survey RRSH30
Road ID : SH30 Description : State Highway 30
Survey Start : 0 Direction : Increment Length : 0
Distance to Next LRP : 1162
Next LRP Desc : St Matthew's Church
Continuous Events Activated: B
0m
Bump Count : 3 Distance : 237 m Total Dist.: 1147 m
Description Metres Raw Count Speed
#13 End of Interval 910m 11 72km/h
#14 Manual LRP reset #2 BP Petrol Stati 910m 11 62km/h
#15 LRP #2 Chainage BP Petrol Station 907m 11 62km/h
#16 End of Interval 100m 10 72km/h
#17 End of Interval 200m 10 72km/h
#18 Bridge 210m 1 70km/h
F5-Stop BI F7-Int.Result F8-Err F10-End SPACE-Pause ESC-LRP

Figure 6.2: Display During Roughness Survey

© 2001 Data Collection Ltd.

ROMDAS Display

The top of the screen contains basic data describing the basic survey data.

There is a horizontal bar graph which displays the progress of the survey. If the user has defined the length of the section, it will be to scale otherwise it will just show the number of sections covered, cycling continuously until the end of the survey.

Under the horizontal bar graph are three continuous counters. The "Bump Count" is the number of raw roughness counts accumulated so far over the sampling interval. The "Distance" is the current vehicle chainage in m since the last LRP. The "Total Distance" is the total distance travelled. These later two values are only displayed when the chainage is set at LRPs, otherwise only the cumulative distance is displayed (see Section 5.6.4).

As the survey progresses, a the window at the bottom of the screen displays the cumulative distance travelled, the number of raw counts and the speed. When an event key is pressed, the window displays the keycode definition as well as the chainage where the key is pressed (see Figure 6.2). At the end of a sampling interval ROMDAS displays the message "End of Interval".

If GPS data are being collected, the latitude, longitude and altitude are displayed on the bottom of the screen, updated at the user-defined sampling interval.

Continuous Events

Above the bar graph is a display "Continuous Events Activated". When an event key is pressed which corresponds to a continuous event (see Section 5.3.1), the letter of the key is displayed and flashes (see Figure 6.2). This is to remind the operator to press this key again at the end of the event.

LRP Resets

If the option for resetting at LRPs has been selected, the display includes two additional data items:

- the "Next LRP Chainage" is the chainage of the next LRP; and,
- the "Next LRP Description" is its description.

The values displayed are from the LRP data file specified in the survey data screen and are illustrated in Figure 6.2.

Box 6.3 Problems?

The ROMDAS v hardware interfaces from v 3 onwards facilitate problem solving. If the software is communicating correctly with the interface the green LED should be flashing. If the roughness meter or the odometer are sending signals to the interface their respective LED's should flash each time a signal is received. See Chapter 4 for a discussion on problem solving.

During the survey, the PC will beep when approaching an LRP, with an increasing number of beeps as one gets closer. The operator presses the ESC key when they are adjacent to the LRP. If this is not done within the user specified interval (default 100 m — see Section 5.6.2),

© 2001 Data Collection Ltd.

ROMDAS gives a warning message and then changes the display to the next LRP. ROMDAS has a checking routine which will prevent the operator from pressing the ESC key twice until several seconds have elapsed.

F5 - Halt BI Recording

Pressing the F5 key halts the roughness meter recording. This feature is used in the event that you wish to exclude part of the road from the survey (for example a bridge). The roughness count entered into the data file is the **equivalent roughness count** for the section, and is calculated as follows:

ECOUNT = COUNT * SAMPLEIN / MEASURED

where	ECOUNT	is the equivalent roughness count in counts/sample interval
	SAMPLEIN	is the sampling interval in m (usually 100 m)
	MEASURED	is the length of the sampling interval roughnesses were measured over in m

For example, if you measured for 70 m out of a 100 m interval and there were 10 counts, the equivalent roughness would be 14.

If you wish to use this option you must activate it under the **SETUP|OPTIONS|ROUGHNESS SURVEY** menu (Section 5.6.2). The raw data file will contain the chainages and the roughness readings when this key was pressed so that the data can be analysed external to ROMDAS.

NOTE: It is possible to associate halting the BI with any keycode event. This is done by setting the field STOP_BI in the event file to T instead of F (see Section 5.3.1).

INS - Inserting a Location Reference Point

New LRPs can be defined by selecting "D" in the roughness opening screen under 'LRP Reset'. During the survey the INS key is used to define the LRP chainage. A window will open where you can type the description of the new LRP and this name along with the chainage will be stored in the LRP data file.

Box 6.4 Using a Mouse

A mouse can be adopted to reduce the need of using the keyboard during a survey. As described in Section 5.5.3, any three keys from the keyboard can be assigned to a three button PS/2 mouse. For example, the ESC and F10 keys could be assigned and the mouse used at LRPs and to stop the survey.

Interrupting the Survey

If it is necessary to interrupt the survey, for example due to other traffic, intersections, etc. the operator should press the SPACE bar, unless this has been reset to another key as described in Section 5.5.2. This will pause all data collection until it is pressed a second time. Alternatively, the survey can be ended (see below) and restarted later. This is done by specifying the same file name as an existing file. The new data will be appended to the end of the file and the chainage will be measured from the last location.

© 2001 Data Collection Ltd.

Box 6.5 In Case of Error

ROMDAS is a real time data acquisition system so if, for example, you have entered a wrong LRP it is not possible to erase it. However, if you do make a mistake press the F8 key and the comment for the next interval will have the term "F8 ERROR" added to it. This will enable you to identify the data for sections where errors arose and correct them manually (as long as you have kept a record of the error). Please note that you may need to wait a few seconds after making the error since ROMDAS will not allow certain keys to be pressed within a few seconds of each other.

Ending the Survey

At the end of the survey the operator must press the F10 key. They will then be given 4 options:

S	Save the data
A	Abandon the data
O	Survey the other side of the road
N	Start a new section

The functions of these options are clear except for the "O" option. Selecting O indicates that you wish to survey the opposite direction on the same road[1]. The operator should turn the vehicle around and as they pass the end point of the survey for the other side, press the SPACE bar once again to start the survey. ROMDAS will then automatically calculate the beginning and end points of the sections so that the same chainages are used in both directions (see Section 2). Once the decreasing chainage has been exhausted the program will save the files. An example of this is illustrated in Figure 6.3.

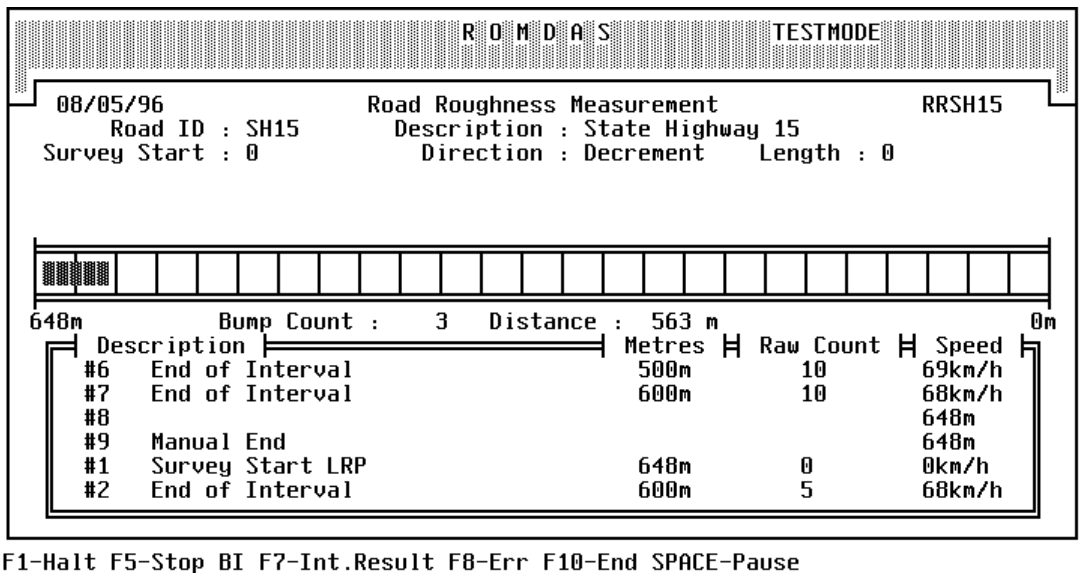

R O M D A S TESTMODE
08/05/96 Road Roughness Measurement RRSH15
Road ID : SH15 Description : State Highway 15
Survey Start : 0 Direction : Decrement Length : 0
648m Bump Count : 3 Distance : 563 m 0m
Description Metres Raw Count Speed
#6 End of Interval 500m 10 69km/h
#7 End of Interval 600m 10 68km/h
#8 648m
#9 Manual End 648m
#1 Survey Start LRP 648m 0 0km/h
#2 End of Interval 600m 5 68km/h
F1-Halt F5-Stop BI F7-Int.Result F8-Err F10-End SPACE-Pause

Figure 6.3: Example of Recording On 'Other Side' of the Road

[1] You can also survey the other side of the road by selecting the file name of an existing file. You will be given the option to **Continue** the existing survey or to survey the **Other** side. If the latter is selected it will function exactly the same as if you had turned the vehicle around immediately after completing one side.

© 2001 Data Collection Ltd.

NOTE: If you are defining LRPs in a survey you can press the F9 key to end the survey instead of F10. This will bring up the LRP definition box so you can define the LRP where you ended the survey.

6.5 FILES

Roughness Survey Data

The roughness survey will create a file with the name RRxxxxxx.DBF, where xxxxxx is the 6 character user supplied name from the survey input screen. The format of this file is discussed in ANNEX M.

Survey Log File

In addition, each survey day ROMDAS creates a file call RLddmmyy.DBF, where dd=day; mm=month; yy=year. This file contains a summary of all the survey information on the input screen, i.e. file name, road ID, description, etc. It acts as a daily survey record and can be printed as described in Chapter 12.

Keyboard Rating File

The data entered via the keyboard are stored in a file with the name RKxxxxxx.DBF whose format is described in ANNEX M. The xxxxxx is the 6 character user supplied name from the survey input screen.

Location Reference Points

Any location reference points will be stored in a file called RPxxxxxx.DBF whose format is discussed in ANNEX M.

Box 6.6 Your First Survey

There are several ways to conduct your first roughness survey. It is strongly advised that you use location reference points (LRPs) for all roughness surveys. This will help you to reconcile results from different years.

The best approach is to first conduct an LRP survey (see Chapter 9) separate to the roughness survey. This will allow you to stop the vehicle and locate missing LRPs without having to worry about the roughness data. If this is not practical, you should consider defining the LRPs during the roughness survey. This is done by entering a D in the LRP file name in the opening roughness screen. When manually defining LRPs it may be appropriate to manually reset the roughness interval. See the **SETUP|OPTIONS|ROUGHNESS SURVEY** menu described in Chapter 5.

© 2001 Data Collection Ltd.

7. TRAVEL TIME AND CONGESTION SURVEYS

The speed survey option is designed to collect data on travel times and accelerations. It is used for floating car surveys as well as congestion evaluation through the acceleration noise.

ANNEX N has step-by-step instructions to running a speed survey.

The data are collected at user defined intervals (default = 1 s) and consist of the cumulative distance travelled and the cumulative time when the observation was made. The interval can be changed as described in Section 5.6.1.

During speed surveys you can define new LRPs, record keycode events and store GPS data.

In common with roughness surveys, it is recommended that LRPs be used in all speed surveys. This will ensure that data from successive surveys can be correlated with each other. This is particularly important for travel time surveys which are used to evaluate level of service on road networks.

Figure 7.1 shows the opening screen for the speed surveys. The data items are essentially the same as those in roughness surveys except the sampling interval is the time (in seconds) between measurements; here 1.0 s.

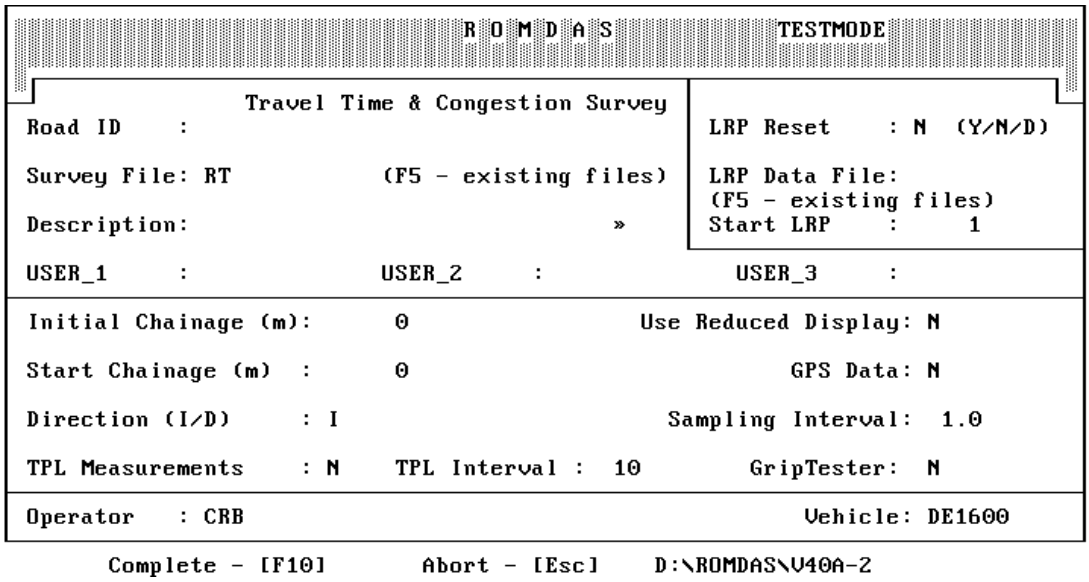


Figure 7.1: Speed Survey Opening Screen

Figure 7.2 shows the display during the speed survey. The display shows the cumulative chainage and times as well as any keycode events. It will be noted that the times are not exactly 1 s. This is because of the nature of the timing on the computer.

© 2001 Data Collection Ltd.

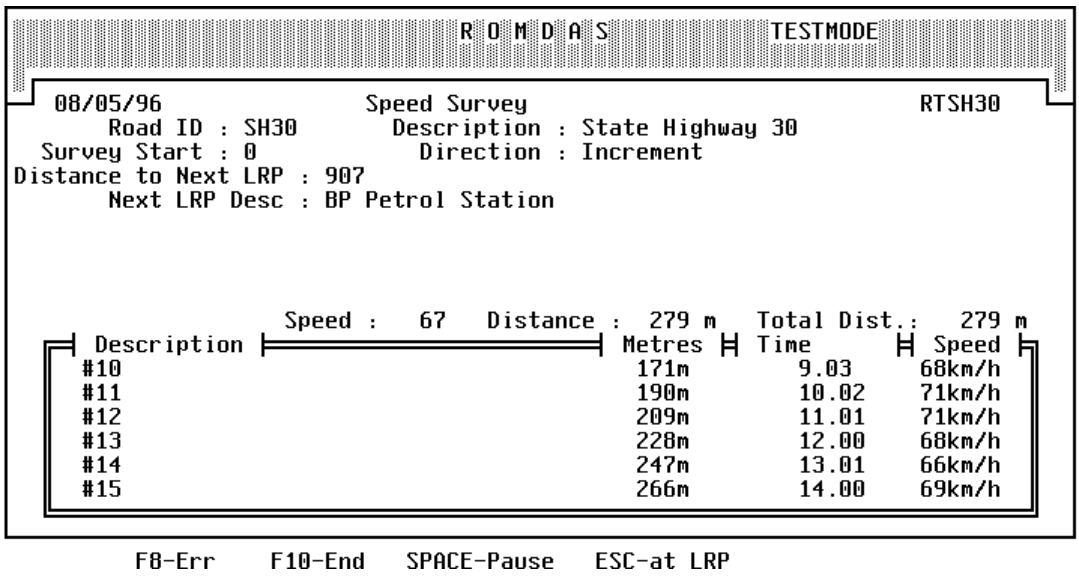

R O M D A S TESTMODE
08/05/96 Speed Survey RTSH30
Road ID : SH30 Description : State Highway 30
Survey Start : 0 Direction : Increment
Distance to Next LRP : 907
Next LRP Desc : BP Petrol Station
Speed : 67 Distance : 279 m Total Dist.: 279 m
Description Metres Time Speed
#10 171m 9.03 68km/h
#11 190m 10.02 71km/h
#12 209m 11.01 71km/h
#13 228m 12.00 68km/h
#14 247m 13.01 66km/h
#15 266m 14.00 69km/h
F8-Err F10-End SPACE-Pause ESC-at LRP

Figure 7.2: Speed Survey Display

The operation during the speed survey are similar to the roughness surveys: you can pause the survey, press the F8 key to log an error, or halt the survey with the F1 key.

Upon completion of the survey (F10) a file is stored which contains data on the time and distance travelled. These data are analysed to establish three statistics:

- **average speed**: this is defined as the cumulative distance travelled divided by the cumulative time. When LRPs are used the value represents the average speed since the last LRP. It is reported in km/h.
- **instantaneous speed**: this is the speed over the last observation interval (i.e between the 1 s intervals). It is the change in distance divided by the change in time. It is reported in km/h.
- **instantaneous acceleration**: this is calculated as the change in instantaneous speed divided by the change in time. It is reported in m/s^2.

Examples of the data and the resulting processed values are given in ANNEX M.

NOTE: If you are defining LRPs in a survey you can press the F9 key to end the survey instead of F10. This will bring up the LRP definition box so you can define the LRP where you ended the survey.

Box 7.1 Accuracy of Surveys

It must be appreciated that the accuracy of the survey is dependent upon the number of pulses from the vehicle odometer to ROMDAS. If, for example, the calibration factor is 1000 this indicates that there are 1000 pulses/km or 1 pulse/m. The accuracy of the measurements will therefore be +- 1 m/s, or +- 3.6 km/h. The higher the resolution of the distance measurement the better the accuracy of the surveys. The DCL high resolution distance measurement instrument (DMI) should be used when high accuracy is required.

© 2001 Data Collection Ltd.

8. KEYBOARD RATING SURVEYS

A keyboard rating survey is conducted to record the chainages of various features or "events" along the road. This is done by assigning different events to the keys on the computer. It is entirely up to the user to define what events they would like to assign to keys. The A to Z and 0 to 9 keys may be used as well as combinations of these keys with the control (Ctrl) key. ANNEX N has step-by-step instructions to running a keycode survey.

It is recommended that wherever possible a separate operator be assigned the task of keycode rating. This will help to get the highest quality results. Most notebook computers allow for an external keyboard to be used at the same time as the internal keyboard, and Section 2.5 shows a special adapter which is available from DCL to allow for the use of two external keyboards simultaneously. We also offer a dedicated 20 key (shown to the right) or 58 key (see Section 2.5) rating keyboards which are ideally suited to rating surveys. Section 2.5 has an example of how the keys would be labelled for a survey. ANNEX T describes how the keyboards are programed for use with ROMDAS.

As described in Section 2.5, there are two types of events which can be recorded:

- **Continuous event** - an event on or adjacent to the road which applies over a section of the road (e.g. a cracked section)
- **Point event** - an event on or adjacent to the road which applies to a point (e.g. a traffic sign).

Before you can do a keyboard rating survey, you must first define what events you want associated with each key. This is done by setting up the file KEYCODE.DBF which is described in Section 5.3.1.

The opening screen is shown in Figure 8.1. The entries are similar to that for roughness surveys (Chapter 6) so please refer to that chapter for a discussion of the individual data items. The only major difference is that under LRP reset you cannot enter 'D', only 'Y' or 'N', although with Y you can also insert new LRP numbers.

Box 8.1 Rating and Defining LRPs In One Survey

Under the Keyboard Rating Survey option you can only add LRPs to an existing file. If you do not have such a file yet you must define it during an LRP survey (Chapter 9) to ensure that the LRP file has the correct RECTYPE numbers. You are able to also do Keyboard Rating during an LRP survey.

When the survey starts you are presented with the screen illustrated in Figure 8.2. When LRP resets are used it will display the chainage of the next LRP along with its description.

As you travel along the road and identify roadside events, the chainage of each event will be displayed. If it is a continuous event, a warning message will show up with the letter of the key pressed flashing. This is to remind the operator that they need to press the key a second time at the end of the continuous event.

© 2001 Data Collection Ltd.

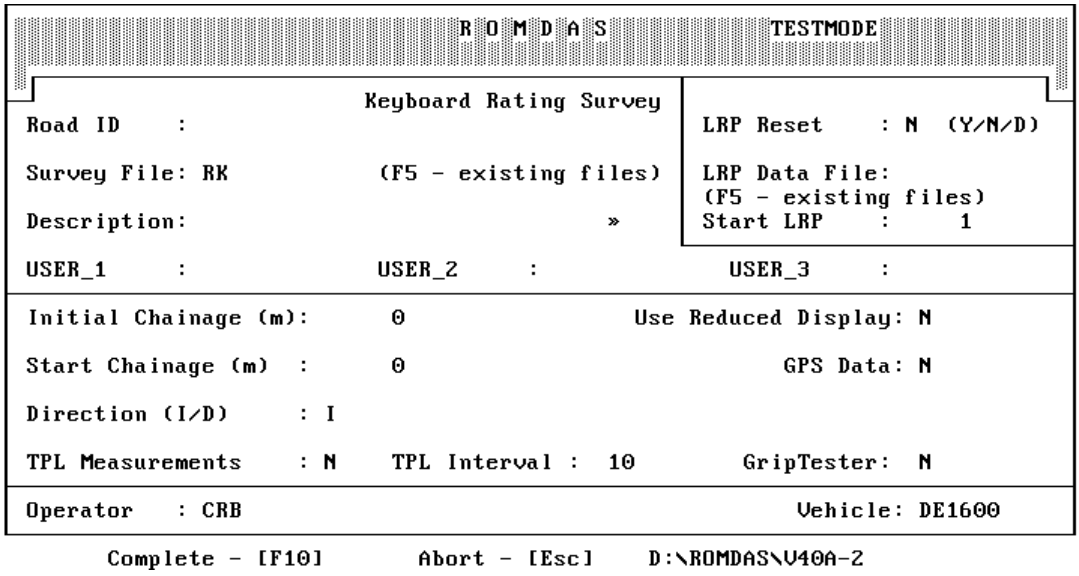

R O M D A S TESTMODE
Keyboard Rating Survey
Road ID :
Survey File: RK (F5 - existing files)
Description: »
LRP Reset : N (Y/N/D)
LRP Data File:
(F5 - existing files)
Start LRP : 1
USER_1 : USER_2 : USER_3 :
Initial Chainage (m): 0
Use Reduced Display: N
Start Chainage (m) : 0
GPS Data: N
Direction (I/D) : I
TPL Measurements : N TPL Interval : 10 GripTester: N
Operator : CRB
Vehicle: DE1600
Complete - [F10] Abort - [Esc] D:\ROMDAS\V40A-2

Figure 8.1: Keyboard Rating Survey Opening Screen

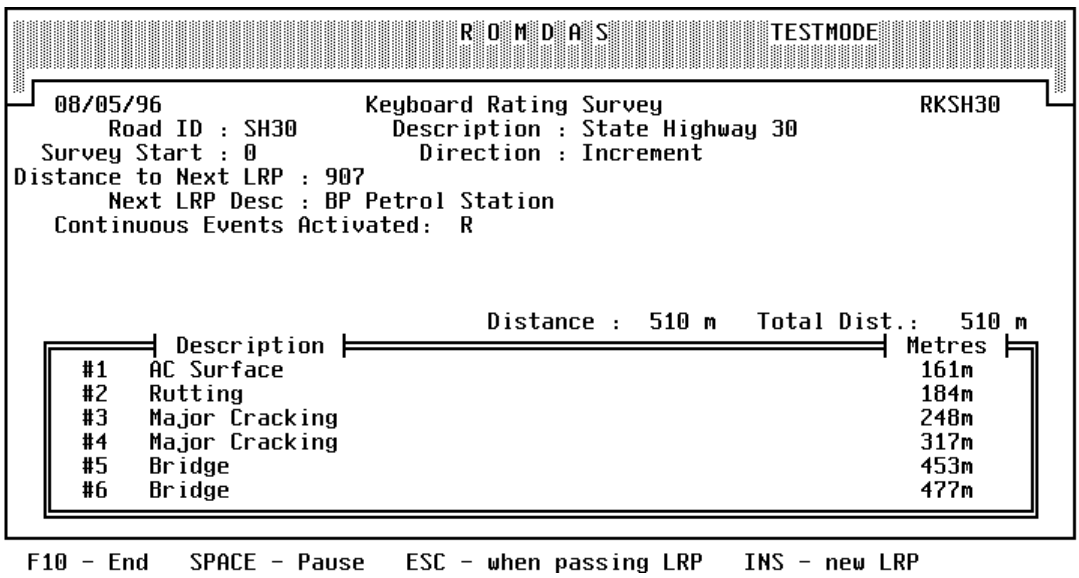

R O M D A S TESTMODE
08/05/96 Keyboard Rating Survey RKSH30
Road ID : SH30 Description : State Highway 30
Survey Start : 0 Direction : Increment
Distance to Next LRP : 907
Next LRP Desc : BP Petrol Station
Continuous Events Activated: R
Distance : 510 m Total Dist.: 510 m
Description Metres
#1 AC Surface 161m
#2 Rutting 184m
#3 Major Cracking 248m
#4 Major Cracking 317m
#5 Bridge 453m
#6 Bridge 477m
F10 - End SPACE - Pause ESC - when passing LRP INS - new LRP

Figure 8.2: Display During Keyboard Rating Survey

Box 8.2 If You Are Using LRP Resets

In the **SETUP|OPTIONS|LRP** menu (see Section 5.6.4) three options for LRP resets are presented. When using LRPs with Keyboard Rating or LRP surveys only two of these options apply. With option (1) the chainage is reset to 0 at the LRP. If option (2) is selected the cumulative chainage is recorded. Option (3), which pertains to resetting the roughness measurements, will give the same results as option (2).

© 2001 Data Collection Ltd.

It is possible to define additional LRPs. This is done by pressing the INS (insert) key. This will open up a window where the operator can type in the name of the LRP. These data are then stored in the LRP file[1] so they can be used in future surveys.

As described in ANNEX M, the data stored consists of the chainage from the last LRP, the LRP number, as well as the keycode definitions.

NOTE: If you are defining LRPs in a survey you can press the F9 key to end the survey instead of F10. This will bring up the LRP definition box so you can define the LRP where you ended the survey.

Box 8.3 Laser Surveyor

If you require the accurate positions of your keycode events we recommend that you use the ROMDAS Laser Surveyor option.

The ROMDAS Laser Surveyor consists of a hand held laser distance measurement device with an integrated compass and inclinometer. These are used to take a 'shot' of the event and the data is recorded by ROMDAS in the data file. These data can then be used with the GPS co-ordinates to obtain a precise location of the event. When coupled with digital photos this offers an excellent way of obtaining the detailed locations of the events.

Section 13.6 describes the Laser Survey option and how the data are processed to establish the GPS position of the roadside events.

[1] As discussed in Section 17.2, the RECTYPE for LRP data is 10. When new LRP data are entered into the file these have a RECTYPE of 12.

© 2001 Data Collection Ltd.

9. LOCATION REFERENCE POINT SURVEYS

The Location Reference Point (LRP) Survey is used to establish the chainages of the various LRPs. As discussed in Chapter 2, these LRPs are any permanent fixture adjacent to the road, for example km posts. By having regular LRPs the data collected in the roughness survey can be accurately related to the same sections of road, even when the survey is conducted in different years.

The LRP Survey allows the operator to record both the chainage of the LRPs and their identifiers. At the same time, they can do keyboard rating of events (see Chapter 7) and store GPS data if the vehicle is fitted with a GPS receiver.

ANNEX N has step-by-step instructions to running an LRP survey.

The chainages of the LRPs can be established during a roughness survey by using the 'D' option for LRPs. During the survey the operator presses the INSERT key at an LRP and these are recorded in the file.

However, it is strongly recommended that LRPs be defined in a separate survey to the roughness survey. There are two principal reasons for this:

- the LRPs are the basic description of your network and they should be located as accurately as possible. Since the roughness vehicle will generally be travelling at a speed above 30 km/h such accuracy is difficult to achieve;
- if you have existing markers, such as kilometre stones, it is often necessary to stop the vehicle to read the marker, to remove grass or debris which may be obscuring it, or even to find the marker. This is impossible during a roughness survey.

Selecting this option sees a menu displayed which has similar data items to those used in the roughness survey. Once the operator supplies these data, the survey is ready to commence.

Box 9.1 Digital Photographs

In the **SETUP|OPTIONS|LRP** menu (see Section 5.6.4) there is the option to specify that you will be taking digital photographs of the LRPs. This will see the operator prompted for the frame number of the photo which will be stored in the LRP file. If the type of camera is specified ROMDAS will also generate the file name corresponding to the naming convention of the camera and store this in the LRP file.

The operator will be prompted for the name of the first LRP and this will be assigned the chainage of 0.0 m. The vehicle should then be driven to this LRP and as it is passed the SPACE bar pressed.

Figure 9.1 is an example of the screen presented during a LRP Survey. The current chainage is continually displayed (which is why the value below 'Road ID' in Figure 9.1 is greater than the value in the survey window). When the vehicle is adjacent to an LRP the operator presses the ESC key. A window opens and the operator can type in a description of the LRP. The descriptions of the previous LRPs are displayed in the main display window. The survey may be paused and when completed the operator presses the F10 key and stores the data in a file.

© 2001 Data Collection Ltd.

The example in Figure 9.1 is based on the use of any permanent roadside event as an LRP.

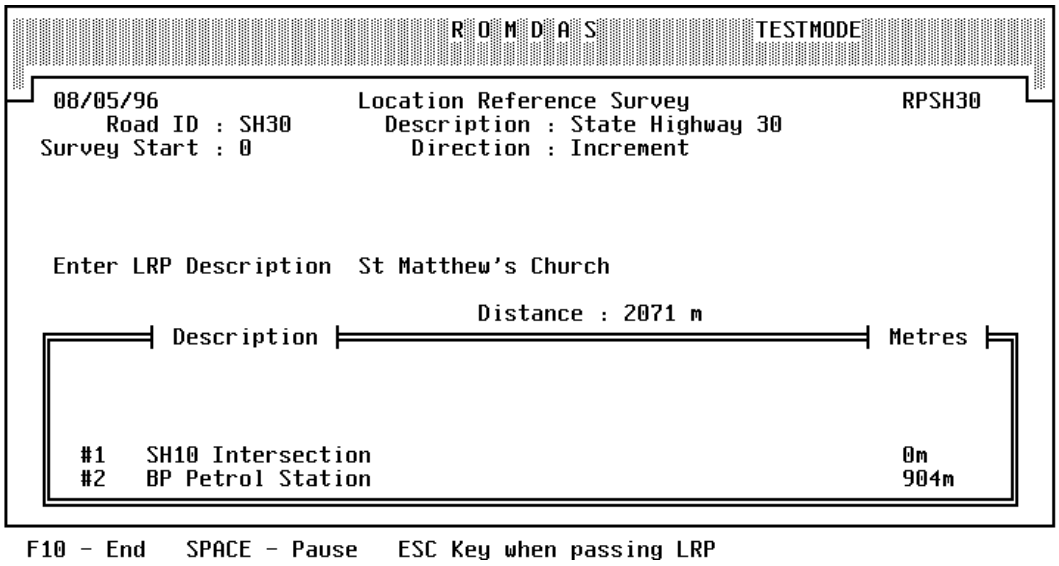

R O M D A S TESTMODE
08/05/96 Location Reference Survey RPSH30
Road ID : SH30 Description : State Highway 30
Survey Start : 0 Direction : Increment
Enter LRP Description St Matthew's Church
Distance : 2071 m
Description
Metres
#1 SH10 Intersection 0m
#2 BP Petrol Station 904m
F10 - End SPACE - Pause ESC Key when passing LRP

Figure 9.1: Location Reference Point Survey

As described in Section 5.3.5, it is possible to pre-define the LRPs. The operator enters an abbreviated code using the ALT key. The full definition given in the LRP Definition file (see Section 5.6.4) is then inserted as if it had been typed.

NOTE: If you are defining LRPs in a survey you can press the F9 key to end the survey instead of F10. This will bring up the LRP definition box so you can define the LRP where you ended the survey.

Box 9.2 Laser Surveyor

If you require the accurate positions of your LRPs we recommend that you use the ROMDAS Laser Surveyor option. As described in Section 13.6, this consists of a laser distance instrument and a directional compass. With the Laser Surveyor and a GPS you will be able to accurately obtain the geo-coordinates of your LRPs.

Figure 9.2 shows the display when the Laser Surveyor is used to establish LRP positions.

© 2001 Data Collection Ltd.

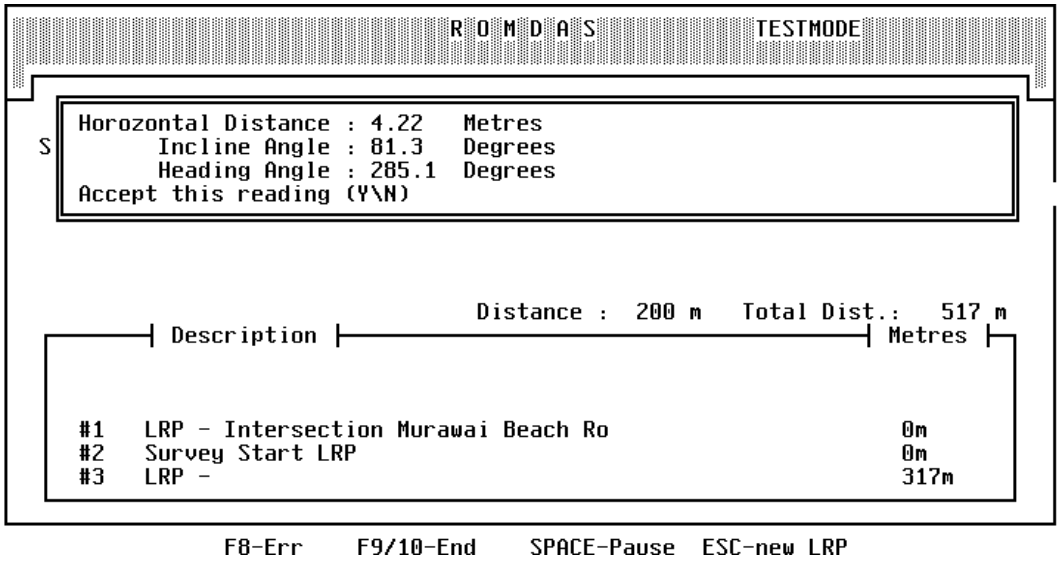

R O M D A S TESTMODE
Horozontal Distance : 4.22 Metres
Incline Angle : 81.3 Degrees
Heading Angle : 285.1 Degrees
Accept this reading (Y\N)
Distance : 200 m Total Dist.: 517 m
Description
Metres
#1 LRP - Intersection Murawai Beach Ro 0m
#2 Survey Start LRP 0m
#3 LRP - 317m
F8-Err F9/10-End SPACE-Pause ESC-new LRP

Figure 9.2: LRP Locations Using Laser Surveyor

Box 9.3 If You Are Using LRP Resets

In the **SETUP|OPTIONS|LRP** menu (see Section 5.6.4) three options for LRP resets are presented. When using LRPs with Keyboard Rating or LRP surveys only two of these options apply. With option (1) the chainage is reset to 0 at the LRP. If option (2) is selected the cumulative chainage is recorded. Option (3), which pertains to resetting the roughness measurements, will give the same results as option (2).

© 2001 Data Collection Ltd.

10. VIDEO SURVEYS

10.1 INTRODUCTION

The ROMDAS video recording system allows a video or camcorder to be used during a ROMDAS survey to record images from the moving vehicle. The most common application is to mount the camera facing forwards to record the right-of-way, although it is also possible to record sideways or to the rear of the vehicle.

The system consists of a character overlay device which is connected to the external monitor port on the notebook computer. For this option to work the computer must support simultaneous display of the internal screen and the external monitor[1]. The overlay device is then connected to a video recorder. The overlay device 'mixes' the signals from the camera and the computer and tapes them on the recorder.

The system will work with any video camera and video recorder combination.

10.2 SYSTEM SETUP AND OPERATION

All data displayed on the notebook screen will be overlaid onto the video tape. Since the normal ROMDAS display consists of a full screen of information, a reduced screen option is available. This is accessed via the **SETUP|OPTIONS|VIDEO SURVEY** menu option (see Section 5.6.3). In order to access this menu a password is required. This is only available to those who have paid an access fee to DCL. This fee is included in the price when purchasing the hardware from DCL.

Box 10.1 False Economy

Whenever you start a survey on a new road is it recommended that you also start a new video tape. This is because of the time it takes to locate sections on tapes with multiple roads on them. What you save in the cost of tapes you more than lose in terms of wasted time when you go to use the tapes.

When the reduced display option is activated the screen display is as shown in Figure 10.1 and Figure 10.2. The screen includes the essential data for the road section being surveyed. The speed displayed is the average speed over the last section. Figure 10.2 also shows the different displays when using the roughness index (RI) or the raw count. When the RI is activated the roughness on the video is approximately the IRI. See Section 5.3.3 for details on using this option.

```
Road ID: SH45                        Description: SH45
Date: 25/02/00          Survey Start: 0          Direction: Increment
Speed:  80     Dist: 89 m                                Rgh Index: 2.0
Events:
```

Figure 10.1: Example of Reduced Video Display - Small Fonts

[1] The only reported incompatibility reported with the ROMDAS video system is with a Toshiba 2110 CS. Some computers (*e.g.* Toshiba Tecra) output at 1072 x 768 resolution. This requires a special overlay device which DCL can supply.

© 2001 Data Collection Ltd.

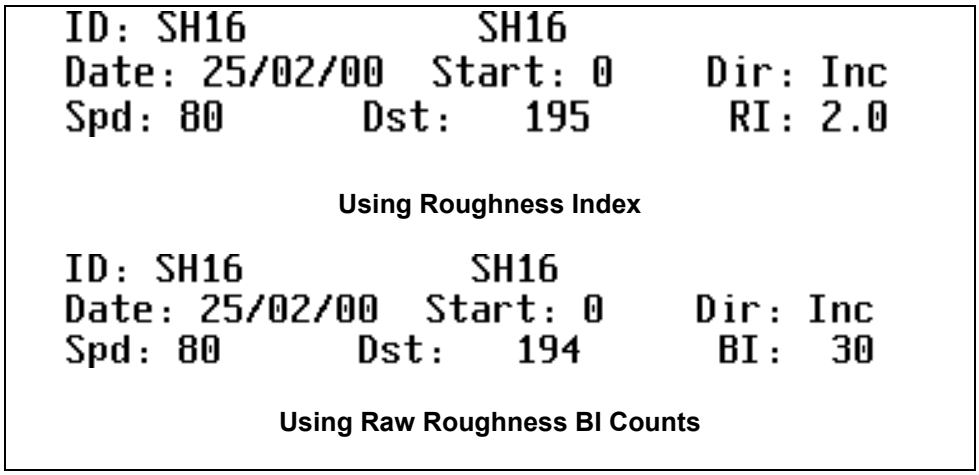

ID: SH16 SH16
Date: 25/02/00 Start: 0 Dir: Inc
Spd: 80 Dst: 195 RI: 2.0
Using Roughness Index
ID: SH16 SH16
Date: 25/02/00 Start: 0 Dir: Inc
Spd: 80 Dst: 194 BI: 30
Using Raw Roughness BI Counts

Figure 10.2: Example of Reduced Video Display - Large Fonts

There are a number of ways in which the display can be customised. This is done through the settings under the **SETUP|OPTIONS|VIDEO SURVEY** menu option (Section 5.6.3):

- **Position of the Display**. It is possible to locate the display box anywhere on the screen.
- **Colour of the Background**. The default background colour is blue. It can also be changed to magenta.
- **Font Size**. There are large (default) and small fonts. The small fonts have more information displayed.
- **Include User Name**. The name of the user can be included at the top of the display box.

The key to successful video taping is to ensure that the zoom and focus to the camera are centred on the features of interest. One should decide on the object of interest and set the system up accordingly. For a right-of-way video one would have a much wider zoom with the camera focused at a distance from the vehicle whereas for recording pavements one would zoom the camera at a spot immediately in front of the vehicle.

Box 10.2 Transparent Overlay Background

If you can see the video image behind the overlay box background this should be checked as follows.

- Using the 'Key Level' command on the overlay hand control, adjust the contrast.
- Check that there is actually 12 v of power going to the unit—if you have a low battery the overlay will not be clear and will flicker.

It is also important to ensure that the heading image is centred in the frame. This is done using the remote control for the overlay device.

The recording is initiated by pressing the record button on the video recorder. Full instructions on the video operation is supplied by the video recorder manufacturer. The system can record in **either** PAL or NTSC format. There are two options for recording: ST (standard play) and LP (long play). This is set using the menu option on the VCR. While

© 2001 Data Collection Ltd.

selecting LP will increase the length of surveys on a tape, it must be recognised that this is done by reducing the quality of the recording. If you plan on digitising the tapes or extracting images you should **NOT** use LP.

The most common problem arising with the video system is problems in reading the data. The size of the font depends upon the resolution of the computer screen. It is therefore **VITAL** that the system be fully tested **BEFORE** you start your surveys. The testing should consist of taking videos with the ROMDAS system and then playing them back on a full size television screen to verify that the fonts are legible. There are a number of options on the overlay device for adjusting the contrast and ROMDAS also allows you to have different coloured backgrounds. Be sure to also consider the positioning of the text—i.e. do you want it at the top, middle or bottom of the screen.

Box 10.3 Large Fonts

The large font display requires that the computer video adapter supports CGA mode. The software invokes this mode which serves to increase the size of the fonts. At the end of the survey it reverts to the standard VGA mode. If there are problems check that the computer supports CGA. This is done by typing the MS-DOS command *mode CO40*. The display should now be 40 x 25 with large fonts. Typing *mode CO80* will revert back to the standard 80 x 40 mode. If your machine does not support CGA you will have to use the small fonts or another computer. The system has been tested successfully on a number of Toshiba notebooks.

If you are trying to locate frames, the video records at approximately 30 frames/s. In the ROMDAS log files called RDxxxxxx.DBF you will find the time of each event in s. Multiplying this by 30 will tell you the frame number of each event. Some video recorders or computer controlled systems allow you to fast forward to a specific frame number, or you can obtain the ROMDAS workstation software which has been designed to do this. This software is provided free with the ROMDAS video system and is described in Section 10.3.

If there are several features of interest it is possible to use up to 4 cameras at once with a multiplexer to record the images on a single tape. This sees the images from each camera placed on successive frames on the tape, cycling between each camera. This feature is useful for recording additional information, such as roadside developments. Since the multiplexer takes approximately 0.85 s with each camera, the images are not continuous from each camera as the vehicle travels along the road. Given the vehicle speeds (usually 15 m/s or more), this option works best with 2 - 3 cameras.

Another option which overcomes the discrete frames from the multiplexer is to use a quad-splitter. This sees the images from the 4 cameras recorded simultaneously in 4 "boxes" on the screen. The disadvantage of this option is the loss of image quality as it is only 25% of the regular image size.

Box 10.4 Multiple Cameras: The Recommended Way

Multiplexers and splitters are options but they do not give the best results. If it is important to have multiple cameras it is recommended that you use multiple systems—*i.e.* a dedicated camera, overlay device and VCR for each. Using a signal amplifier (which we can supply), a single PC will be able drive up to 5 systems simultaneously.

© 2001 Data Collection Ltd.

10.3 DIRECT DIGITISATION

Most ROMDAS users want to store the images on computers. It is possible to eliminate the VCR and digitise the images directly on a second computer. It is anticipated that ROMDAS for Windows will eventually allow for a single computer to be used for both the ROMDAS surveys and digitising.

All that is required is for the second computer to be outfitted with a video capture card. Since notebooks are usually used this is achieved either by a PCMCIA card or using a docking station with a standard PCI card.

The ROMDAS video system will trigger an image capture at a user defined interval (*e.g.* every 10 m). A special cable connects the ROMDAS notebook and the video capture computer. The ROMDAS notebook sends a signal which is used by special software on the video capture computer to trigger a capture. Details on this system are available from DCL.

10.4 ROMDAS VIDEOPLAY

The ROMDAS Videoplay software has been developed for playing back digitised images. An example of the software is given in Figure 10.3.

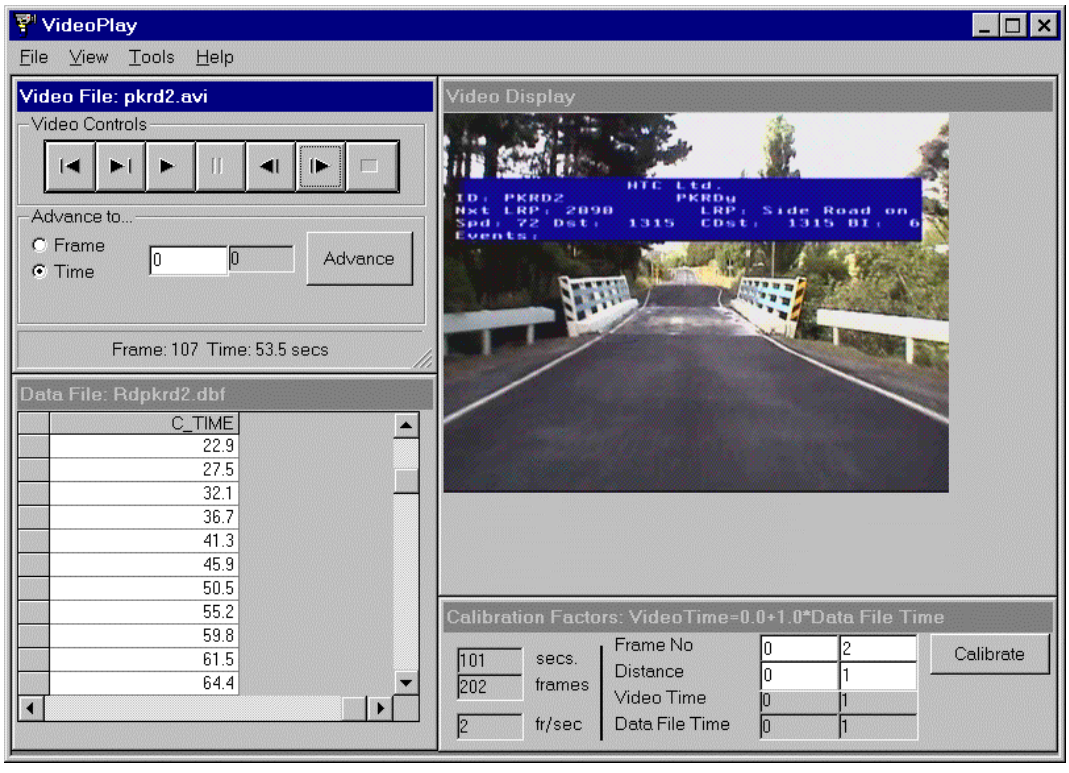


Figure 10.3: Example of Digitised Video Frame

The videos can be digitised using any video capture card. For desktops there are a number available at a range of prices. The only requirement is that the card can create a digitised .AVI file using its software. We recommend using cards which can digitise about 3 frames per second. This is more than adequate for road data and also ensures that your files are not too large.

© 2001 Data Collection Ltd.

Once a .AVI file is created, file can be processed and individual frames extracted to individual files using the ROMDAS Video Workstation software. The software is integrated with the ROMDAS survey file (RD******) so you can assign a target chainage and the video will be advanced to the nearest frame and extract the data. This reduces the large, continuous .AVI files down to a tractable number of individual images which can be manipulated in a number of ways.

It should be noted that the ROMDAS videoplay software only contains very basic video calibration routines. For an accurate calibration the ROMDAS Road Management System (RMS) software is recommended. This optional software is described in Chapter 18.

© 2001 Data Collection Ltd.

11. TRANSVERSE PROFILE SURVEYS

11.1 INTRODUCTION

The ROMDAS transverse profile logger (TPL) is designed to measure the transverse profile of the pavement. These measurements are used to calculate the rut depth. The TPL consists of the following:

- ultrasonic measurement sensor arrays (UMSA);
- master controller;
- aluminium housing for the UMSA which is affixed to the front of the vehicle. There is a 2 m main section and two 0.5 m 'wings' which extend beyond the main section.

Each UMSA consists of 5 ultrasonic sensors and their associated circuitry in an environmentally protected housing. The sensors are spaced at 100 mm intervals and will measure the distance to pavement with an accuracy of $\pm$ 1.0 mm[1]. The main section contains four UMSA while the wings each contain one UMSA. A total of 30 sensors are therefore available when the main section and both wings are being used. A 31st sensor is fired at a fixed target to correct for ambient conditions.

The TPL does not do real time processing of the data. Instead, the data are stored during the survey and downloaded to the computer for post-processing. This allows for a more detailed data analysis than is possible with real-time systems.

The following data are recorded each time a measurement is made:

- the vehicle chainage in m;
- the vertical elevations of each sensor above the pavement;
- the sensor numbers applying to each reading.

The transverse profile measurement is therefore characterised by a pair of sensor numbers and elevations — or a series of x-y co-ordinates when the sensor number is replaced by the location of the sensor relative to the first sensor. Since there may be some variations with the spacings between each UMSA, these spacings are defined under the ROMDAS **SETUP|TRANSVERSE PROFILE LOGGER|TPL SETUP** menu (see Section 5.4.2). In the discussion and examples which follow it is assumed that the distance between UMSA is 100 mm.

The y co-ordinates consist of the time it takes for the ultrasonic signal to travel to the surface and return to the sensor. This is stored as a distance 'count'. When the data are downloaded to the computer these are converted to the actual distance in mm. Data are stored along with the chainage where the measurements were taken. Details of the file structure are given in Chapter 12. ANNEX G gives full details on the TPL protocols.

The following sections describe the design of the TPL, downloading of the data from the TPL to the computer, and how rut depths and distortion are calculated from the TPL data.

[1] This is based on static testing of the system with objects of known heights. The confidence intervals for the means were < 0.5 mm with 95% confidence. Allowing for errors in the 'real world' the measurements can be taken to be $\pm$ 1.0 mm. Working papers on the testing are available at www.ROMDAS.com in the download section.

© 2001 Data Collection Ltd.

11.2 ROMDAS TRANSVERSE PROFILE LOGGER

The ROMDAS TPL operates with up to 30 ultrasonic sensors spaced at nominal 100 mm intervals. The individual UMSA units are connected to each other in series using a 9 pin straight through cable, as well as to the 'Master Controller'. The Master Controller is the interface between the UMSA and the computer[1].

The TPL is connected to the computer via an RS-232 serial cable. Since the ROMDAS hardware interface also must be connected via an RS-232 cable it is necessary to have two RS-232 ports available on the computer. For those computers with only one RS-232 port, a PCMCIA RS-232 card must be used.

Based on a sampling interval defined by the user, the computer sends a trigger signal to the master controller consisting of the current chainage (in m). To avoid interference effects between adjacent sensors, the same sensor is fired in all UMSA at the same time. This is then followed by a firing of the other sensors until all five sensors in the UMSA have been fired. Figure 11.1 illustrates this sequence of firings. The raw data are stored in the master controller along with the chainage where the measurements were taken.

The staggering of the firings means that the resulting transverse profile is not from the same point in space but are instead a composite formed from the five firings. This is illustrated in Figure 11.2.

The firing of all sensors in all UMSA takes approximately 0.12 s, with an additional 0.13 s to store the data. The total longitudinal distance between sensors 1 and 5 in each array therefore depends upon the speed of the vehicle. Table 11.1 shows the theoretical distance over which the sensors are fired as a function of the vehicle speed. In practical terms, if you are travelling below 70 km/h 5 m sampling is possible; above that 10 m.

Box 11.1 Development of TPL

The ROMDAS Web Site and the ROMDAS CD contain a number of working papers detailing the development of the TPL. These include:

- **Validation Against Straight-Edge**. Results of a study using data collected by APSA Ltd. in Chile which compared the TPL to a 1.5 m straight edge.
- **Dynamic Field Testing**. The testing of the TPL measurements in NZ. Both the rut depth measurements (2 m straight-edge) and the ability to dynamically measure kerb height were tested.
- **Static Field Testing**. Comparison of the TPL with very detailed transverse profile data from a TRL Beam.
- **Sensor Accuracy**. Statistical analysis of the accuracy of the TPL elevation measurements (better than 1 mm).
- **Temperature Effects**. The effects of operating conditions on the TPL.

These papers provide important background to many of the TPL features and should be read by all users.

[1] The Master Controller originally stored the data for downloading but ROMDAS now downloads the data in real-time during the survey.

© 2001 Data Collection Ltd.

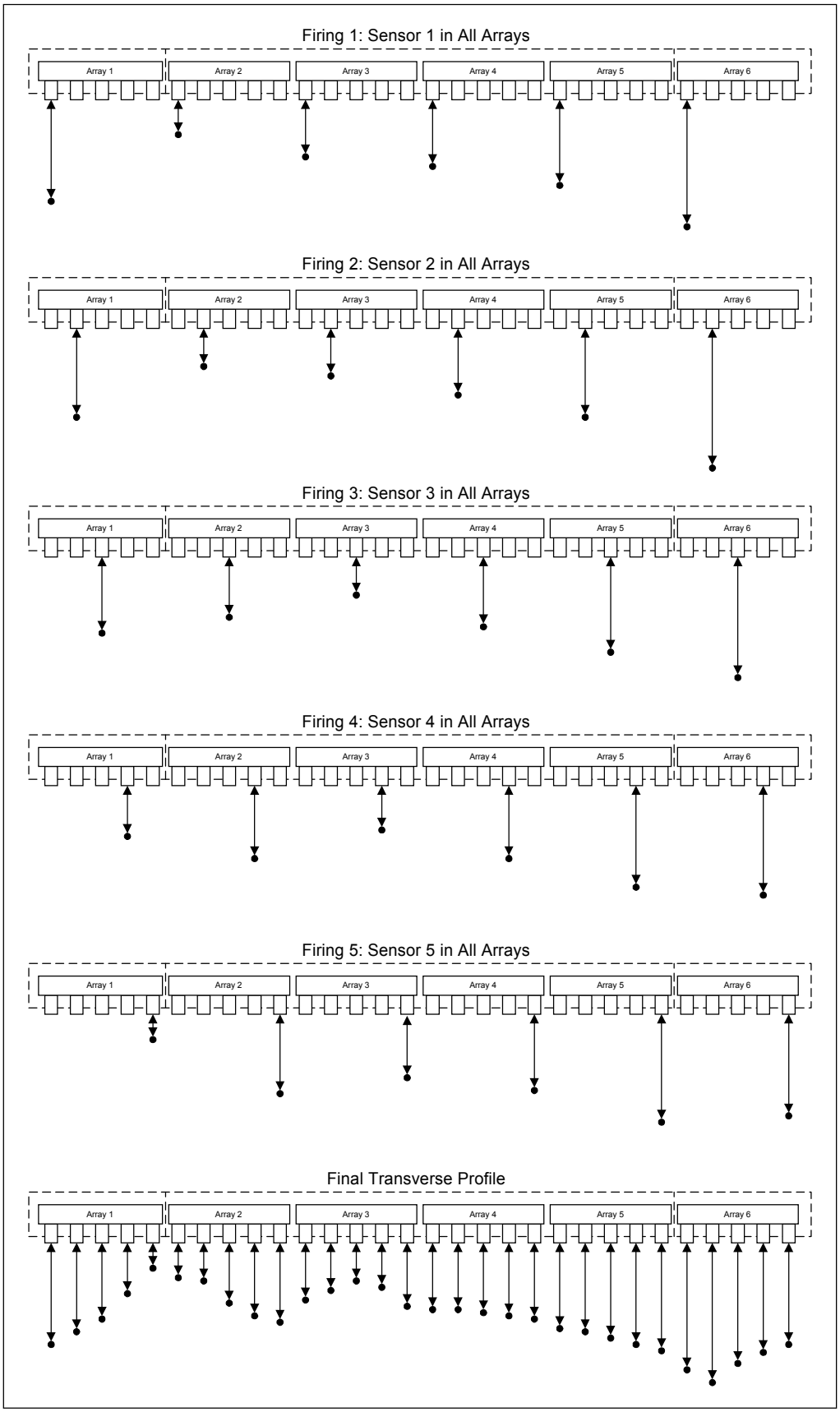


Figure 11.1: Firing Sequence of Transverse Profile Logger

© 2001 Data Collection Ltd.

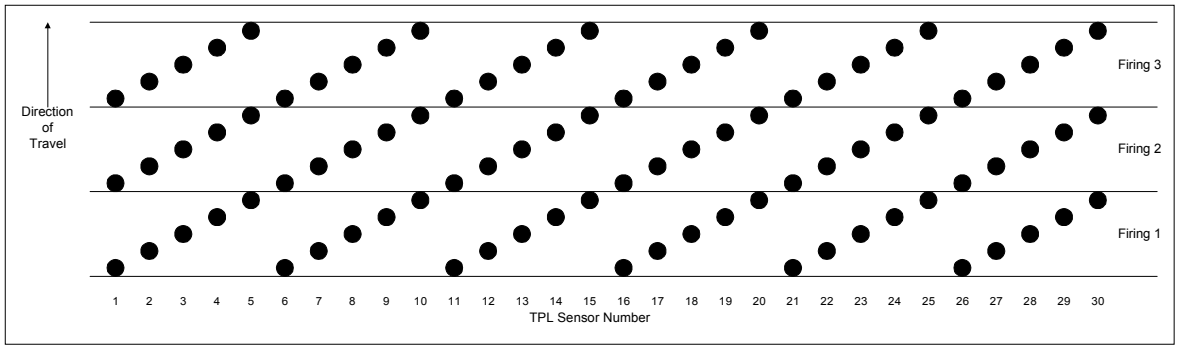


Figure 11.2: Transverse Profile Measurement Locations

Table 11.1: Firing Distance as Function of Speed

Speed (km/h)	Velocity (m/s)	Distance for Firing (m)
5	1.4	0.3
10	2.8	0.7
20	5.6	1.3
30	8.3	2.0
40	11.1	2.6
50	13.9	3.0
60	16.7	4.0
70	19.4	4.6
80	22.2	5.3
90	25.0	6.0
100	27.8	6.6

The TPL has a cover which is used to protect the sensors from the environment. This should be closed at all times except when a survey is in progress.

Before commencing a survey a series of measurements should be taken to 'zero' the sensors. This is done to obtain the relative elevations of each sensor above a straight edge. The measurements should be made using the TPL **Multiple Measurement** Calibration option (Section 5.2.3). The vehicle should be parked on a level section of road and a straight edge placed below the TPL. After the calibration, the **Create Datum Level** option (Section 5.2.3) should be used to determine the calibration factors. When the survey data are processed the elevations are corrected using the datum level values.

11.3 PROCESSING TPL DATA

After the TPL data have been downloaded it is necessary to process the data before analysis. This is done using the **DATA PROCESSING|TPL DATA|CONVERT AND STANDARDISE RAW DATA** option.

Before processing the data ensure that the appropriate data correction options are selected (Section 5.4.4).

The user is prompted to enter the name of the Datum Level file (CTxxxxxx.DBF) created as described in Section 5.2.3. This provides the correction factors for each sensor relative to one another. The user then selects that raw TPL data file (RVxxxxxx.DBF) to be processed. The following processing is done to the data:

© 2001 Data Collection Ltd.

- **Standard Conditions**. Ultrasonics are influenced by temperature, altitude and barometric pressure. To correct for this, the TPL has a sensor which fires continuously at a fixed target. Thus, any variations in the readings of this sensor represent the effects of the above ambient conditions on the ultrasonics. The user defines the distance to fixed target (see Section 5.4.2 and the ratio of the fixed sensor measurement to the standard distance is used to correct the data for ambient conditions.
- **Measurement Calibration Coefficients**. The data are then corrected for the measurement calibration coefficients. As described in ANNEX G, these are created by comparing the TPL output to known distances and analysing the data to establish a linear relationship. The coefficients are entered as described in Section 5.4.2.
- **Relative Heights**. The datum level file contains the correction factors for each sensor relative to each other. These values are added to the individual elevations, after being corrected to standard conditions based on the fixed target measurement during the calibration.

To illustrate this process, consider the following example:

Standard Conditions - The distance to the fixed sensor is 200.0 mm
Measurement Calibration Coefficients - The calibration equation is 10.0 + 0.9 DISTANCE
Relative Heights - The relative height for the sensor is -2.0 mm and this was established with the fixed sensor reading 300 mm.
Sensor Readings - The readings of the sensor was 302.0 mm with a fixed sensor reading of 222.0 mm.

1. Correct the raw data for ambient conditions:

   RAW_1 = 302.0 x 200.0/222.0 = 272.1 mm

   This means that although the sensor measured 302.0 mm, since the fixed sensor was over measuring by 11% (222.0/200.0) the true distance is 11% lower than the measured 302.0 mm – 272.1 mm.

2. Measurement Calibration Coefficients

   The actual measurements at standard conditions is established as:

   RAW_2 = 10 + 0.9 RAW_1
   = 10 + 0.9 x 272.1 = 254.9 mm

   Although the instrument was measuring 272.1 mm the actual distance corresponding to that measurement is 254.9 mm.

3. Relative Distance

   The relative distance for this sensor is -2.0 mm but this was at a standard condition of 300.0 mm. The actual relative distance is:

   REL_DIST = -2.0 x 200.0/300.0 = -1.3 mm

4. Final Elevation

   The final elevation is the calibrated distance plus the relative distance:

© 2001 Data Collection Ltd.

ELEV = 254.9 - 1.3 = 253.6 mm

NOTE: If the fixed sensor number is set to 0 under TPL Setup, the fixed sensor corrections will be ignored. This is **NOT** recommended since the TPL measurements are sensitive to temperature and altitude.

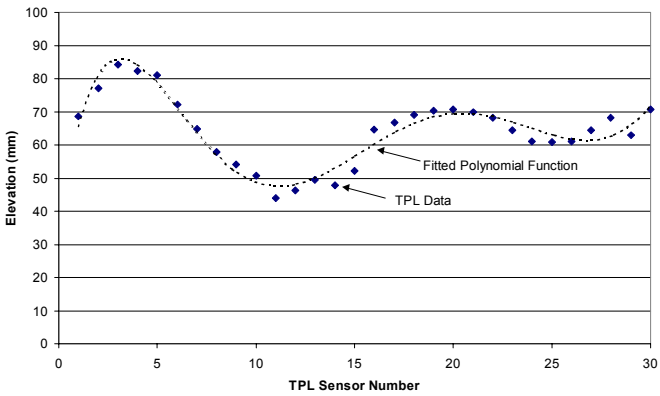
11.4 ANALYSING TPL DATA

11.4.1 Introduction

There analyses the TPL data and calculates the rut depth using two methods:

- Rut depth under a straight-edge
- Pseudo-rut depths

The raw TPL data may have 'noise' in the readings which may lead to a mis-estimate of the rut depths. As described in Section 5.4.3, the data can be smoothed using a 6th degree polynomial equation. This sees the equation fitted to the data (as in the figure to the right) and then the profile values predicted from the equation. The smoothed values are then used in all calculations. This option can be turned on or off by the user.



11.4.2 Rut Depth Under a Straight-Edge

The transverse profile data are analysed to determine the rut depth under straight edge. The straight edge length is user-definable between 1.0 - 3.0 m. The analysis method is based on that developed for the US Strategic Highway Research Program (SHRP) by Hadley and Myers (1991)[1]. Two statistics are calculated:

- the rut depth under a user-defined straight edge; and,
- the transverse profile distortion.

Rut Depth

The rut depth algorithm can analyse any straight-edge length up to the 3.0 m, however, the straight-edge must be expressed in terms of multiples of 0.1 m.

When a straight-edge is laid over a wheelpath, it rests upon the two high points under its span. The rut depth is defined as the maximum vertical distance between the straight-edge and the pavement. This is illustrated in Figure 11.3 for two wheelpaths under a 1.2 m straight-edge and a hypothetical transverse profile.

[1] Hadley, W.O. and Myers, M.G. (1991). Rut Depth Estimates Developed from Cross Profile Data. SHRP Long Term Pavement Performance Program Technical Memo AU-179, Texas Research and Development Foundation, Austin.

© 2001 Data Collection Ltd.

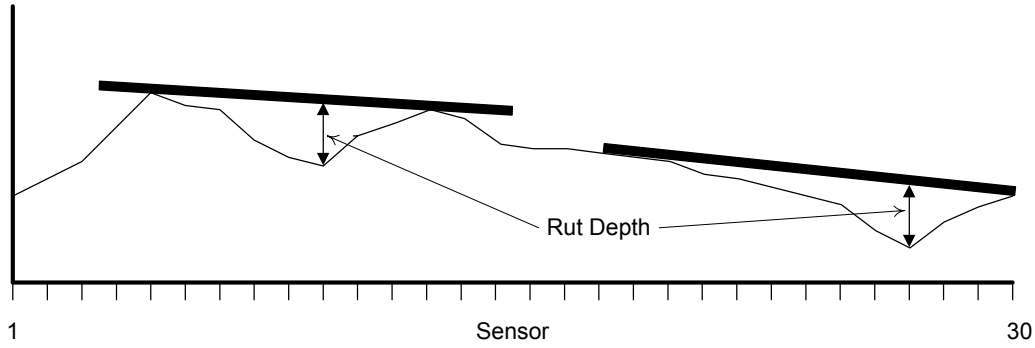


Figure 11.3: Calculating Rut Depth from Transverse Profile

The analysis starts at sensor 1 which is the reading closest to the pavement edge. It progresses until the rutting in one wheelpath is established. It is then repeated for the second wheelpath starting at sensor 30 and moving downwards. If the 'wings' are not used the calculations start with sensors 6 and 25 respectively.

To illustrate the analysis process consider Figure 11.4-A which shows a set of hypothetical transverse profile elevations. The algorithm places the end of the straight-edge at a starting point. For each start point, the slopes are calculated between it and all successive points which would fall within the span of the straight-edge (e.g. 12 points for 1.2 m straight-edge). Figure 11.4-B illustrates this using Sensor 3 as the start point.

The maximum of these slopes is identified (Sensor 5 in Figure 11.4-B). Two criteria are used to establish whether or not this is a viable placement point for calculating a rut depth. If either of these are met the current starting point will not produce a rut depth and the analysis moves on to the next starting point. These criteria are:

- if the maximum slope is less than the slope between the start point and the preceding sensor;
- if the maximum point arises for the point adjacent to the starting point.

Once a viable placement point has been established, the vertical distance of all intermediate placement points are established. In Figure 11.4-C the start point is Sensor 5 and the maximum slope point is Sensor 12. Here, the maximum slope is that closest to the horizontal plane since all elevations are below that of Sensor 5. Figure 11.4-D shows the various possible rut depths for these two points.

For that starting point, the rut depth is the maximum of the vertical distances of all intermediate points. It should be noted that in calculating the rut depth the change in horizontal span due to tilting is assumed not to be significant.

For each possible starting point a maximum rut depth is derived. The largest of these values is taken as the rut depth for the wheelpath in question.

To minimise computation time, the number of possible starting points to analyse for each wheelpath can be limited. Hadley and Myers (1991) indicate that the maximum elevation usually arises within 0.6 m of the pavement edge so the default value used with ROMDAS is 0.6 m. However, this can be changed under the **SETUP|TRANSVERSE PROFILE LOGGER|TPL SETUP** menu (Section 0) up to 1.5 m.

© 2001 Data Collection Ltd.

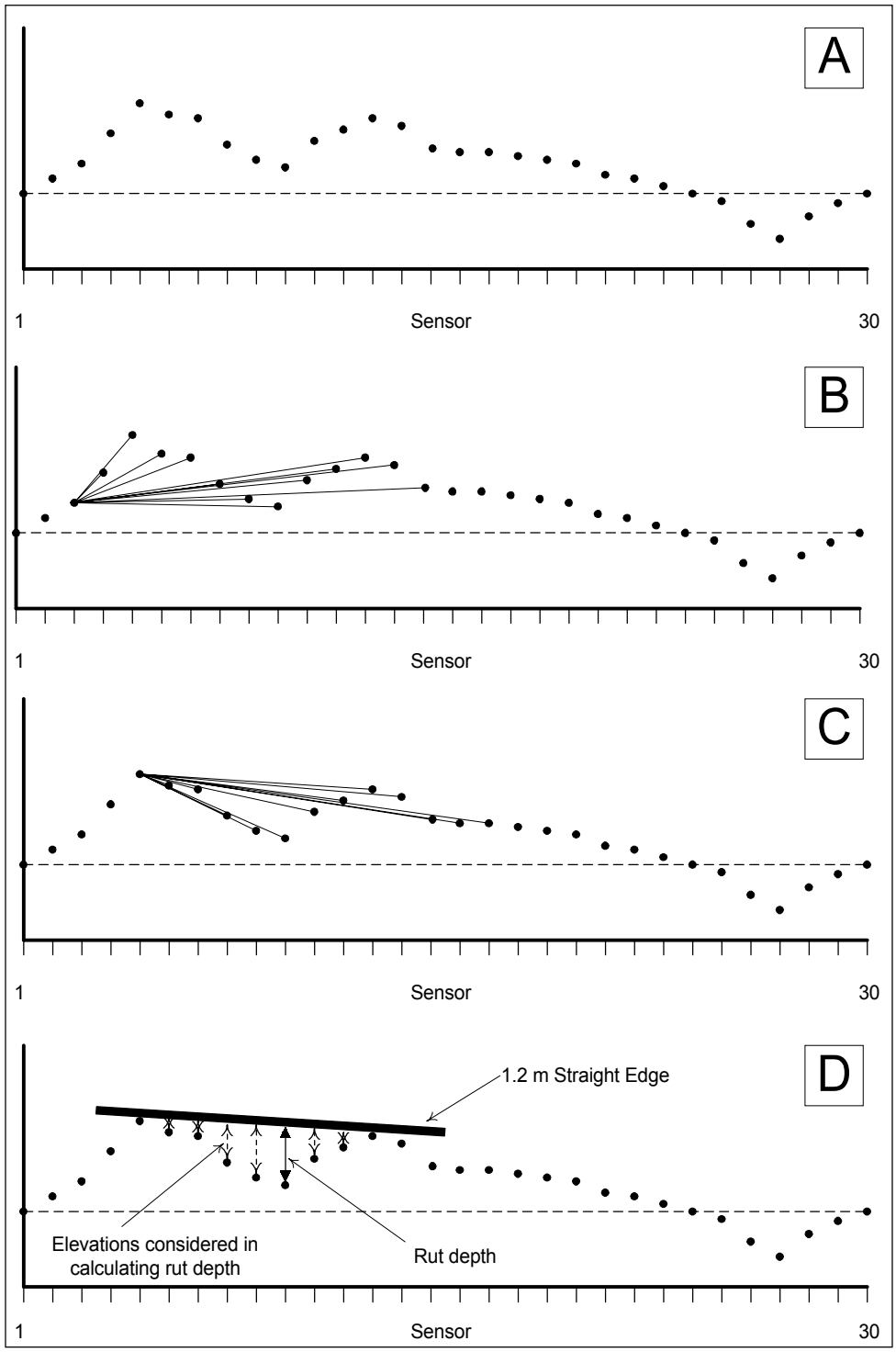


Figure 11.4: Example of Calculating Rut Depth

Transverse Profile Distortion

Hadley and Myers (1991) outline a method for using the distortions in the transverse profile to identify the potential source of rutting.

© 2001 Data Collection Ltd.

Distortion is defined as "the unit volumetric change in a [transverse] profile from its original cross slope orientation to that of the measured rutted configuration." There are two components of distortion:

- uplift of the pavement gives rise to **positive** distortion. The uplift can be related to shoving within the asphalt surface layer(s), rutting in the upper pavement layers, or, possibly, soil swelling;
- **negative** distortion consists of a downward displacement of the pavement. This can be due to rutting in the upper pavement layer or, in extreme cases, subgrade effects.

The net transverse profile distortion is calculated using a finite element integration technique. A segment is defined as the product of the elevation and the distance between the sensors (i.e. based on the x-y co-ordinates). The distortion is the sum of the segments for all sensors.

The base cross profile is defined from the average elevations of the first three and last three sensors to minimise the impact of shoulder/edge drop off:

$$Y_L = \frac{Y1+2Y2+Y3}{4} \qquad Y_R = \frac{Y28+2Y29+Y30}{4}$$

where Y_L is the left elevation in mm
Y_R is the right elevation in mm
Y1 to Y30 are the elevations of sensors 1 to 30 in mm

This approach is not used when the wings are not employed since it is assumed that there is little likelihood of edge drop off influences.

As shown in Figure 11.5, there are three cases which arise based on the net distortion:

- **negative** - if the rutting is severe and the distortion is almost completely negative this corresponds to a displacement of the pavement layers and the probable cause is subgrade rutting (Figure 11.5-A);
- **zero** - if the net distortion is approximately zero, i.e. it is evenly divided between upward and downward movement, this suggests rutting arising in the upper pavement layers (Figure 11.5-B);
- **positive** - when there is more uplift than displacement the net distortion will be positive which is indicative of shoving (Figure 11.5-C).

The distortion is reported both as an absolute value and as the ratio of positive to negative distortion.

11.4.3 Pseudo-Rut Depths

As illustrated in Figure 11.6, 'pseudo-ruts' are defined as the difference (in mm) between the high point and the low points. This is a useful measure when only a portion of the rut bar is used—for example just the 2 m main section—and it has been found to give very repeatable results.

The pseudo-ruts are calculated for the left and right wheelpaths, and also averaged.

© 2001 Data Collection Ltd.

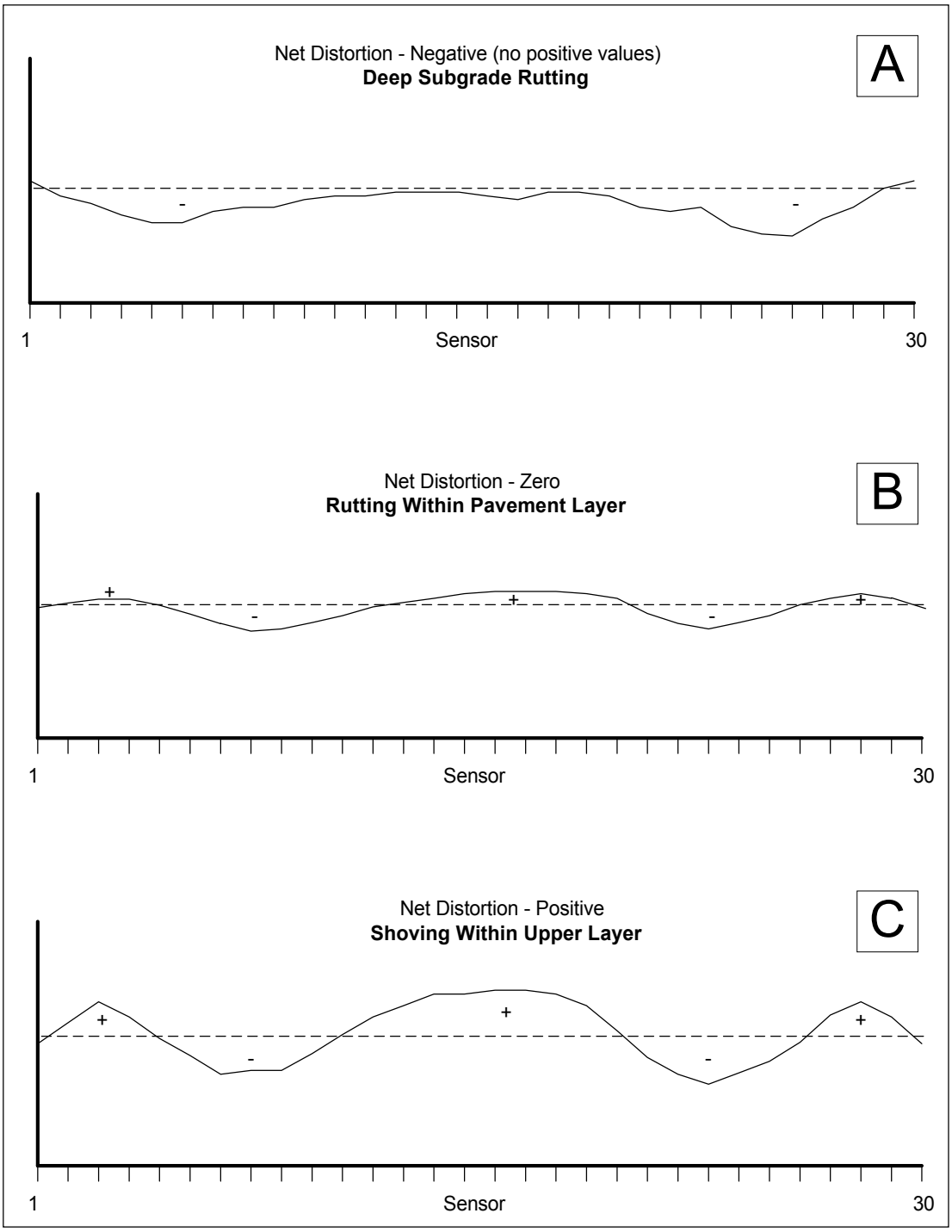


Figure 11.5: Pavement Distortion Possibilities

© 2001 Data Collection Ltd.

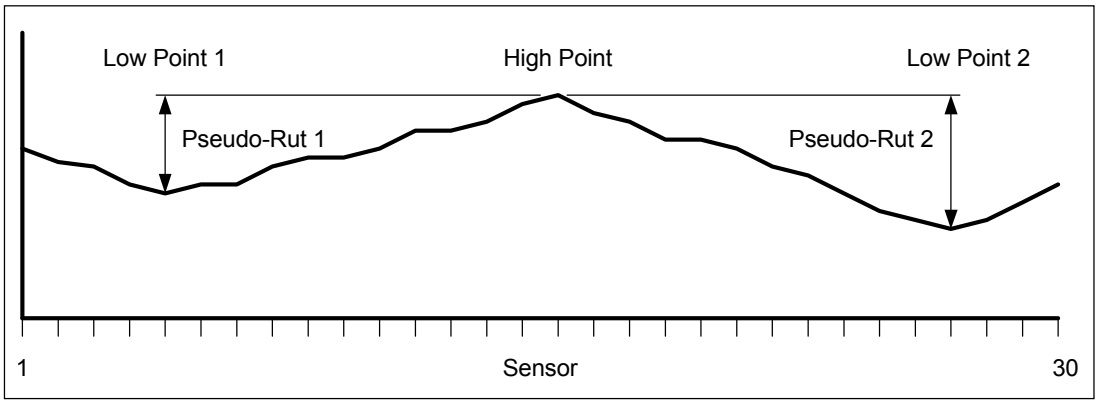


Figure 11.6: Definition of Pseudo-Ruts

11.5 VIEWING TRANSVERSE PROFILES

The ROMDAS Profile Viewer is a Windows 95 application which has been developed to view and plot transverse profiles. Figure 11.7 is an example of the display from the Profile Viewer.

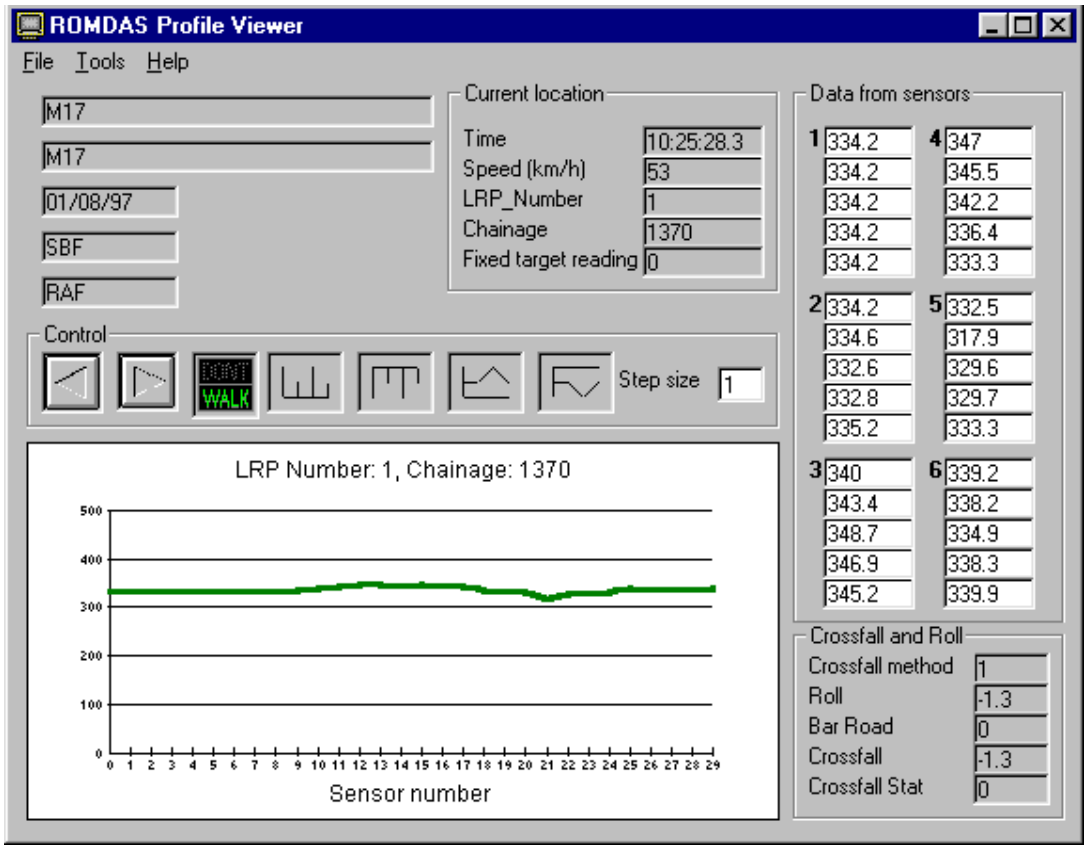


Figure 11.7: Example of ROMDAS Profile Viewer Display

The profiles can be displayed as line or bar charts and expressed relative to the vehicle ('top down') or the pavement ('bottom up'). The measurements are displayed in a data window to the right of the plot for each of the five sensors in the six TPL arrays. Missing

© 2001 Data Collection Ltd.

measurements are highlighted in yellow. If the ROMDAS gyroscope system is installed the crossfall data are displayed in the bottom right corner.

The user can scroll through the file manually or else set a speed and have the program automatically scroll through the file.

The ROMDAS Road Management System (RMS) integrates the display of the transverse profile data with video and roughness data. The RMS is described in Chapter 18.

© 2001 Data Collection Ltd.

12. CROSSFALL SURVEYS

12.1 INTRODUCTION

The ROMDAS crossfall and heading system is based upon a 4 sensor gyroscope system which is mounted on the vehicle. The measurements are made with a fluxgate compass, an inclinometer and two 2-axis gyroscopes. The output form the system is the vehicle pitch, roll and heading to an accuracy of 0.1 degrees. This section describes how crossfall is calculated with the ROMDAS gyro system.

12.2 PRINCIPLES OF CROSSFALL MEASUREMENT

As illustrated in Figure 12.1, the crossfall is the angle of the road to the horizontal. It can be expressed in degrees, m/m or per cent. Although this figure shows the ROMDAS TPL, an approximation of the crossfall can be obtained without using the TPL.

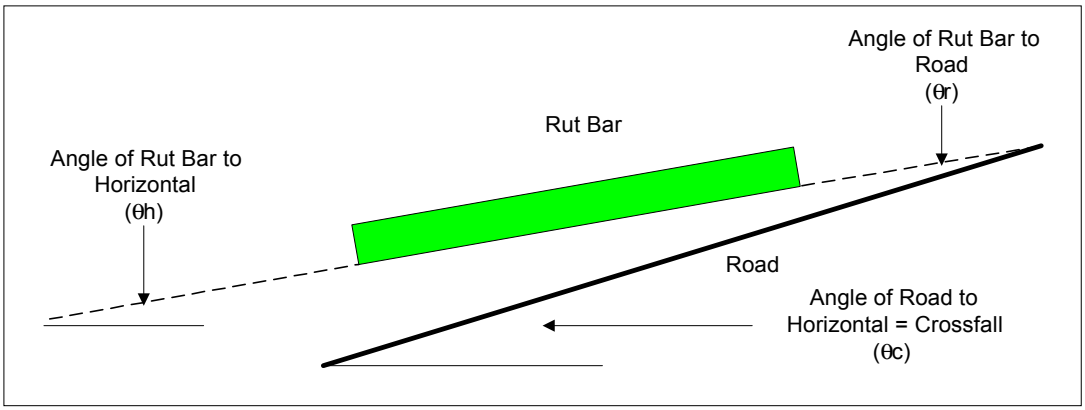


Figure 12.1: Crossfall Measurement Components

In general, the crossfall is calculated from the basic equation:

$$\theta c = \theta r + \theta h$$

where θc is the slope of the road relative to horizontal (crossfall)
θr is the slope of the road relative to the TPL/vehicle
θh is the slope of the rut bar relative to the horizontal

There are three cases which need to be considered in calculating crossfall:

- θr and θh are both positive
- θr is negative and θh is positive
- θr is positive and θh is negative

Figure 12.2 to Figure 12.4 illustrates these three cases for a right-hand drive vehicle.

© 2001 Data Collection Ltd.

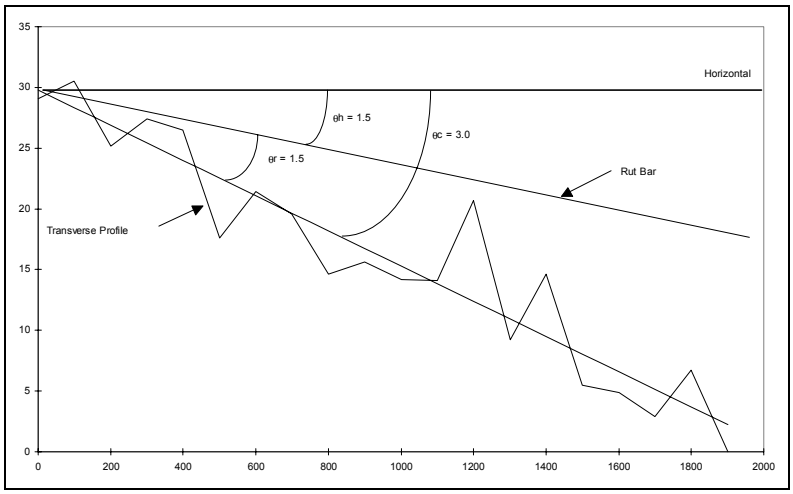


Figure 12.2: Example of Crossfall Calculations—Case 1

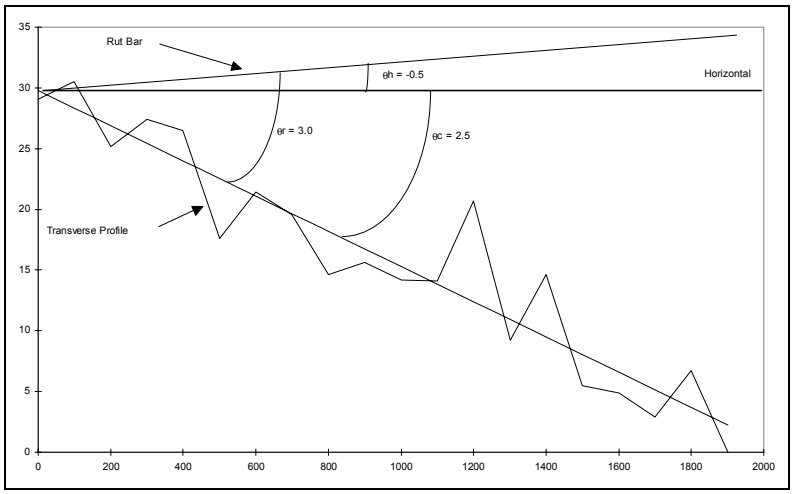


Figure 12.3: Example of Crossfall Calculations—Case 2

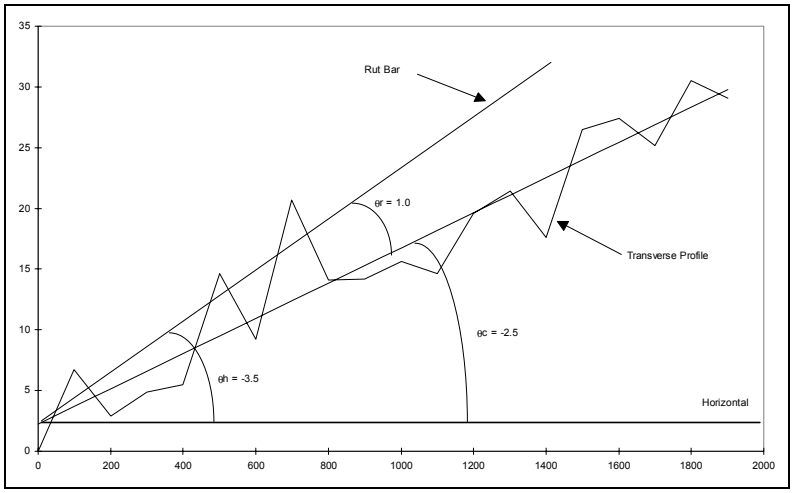


Figure 12.4: Example of Crossfall Calculations—Case 3

The ROMDAS roll gyro gives the value for θh (TPL relative to the horizontal). θr needs to be established from the transverse profile data or by another method.

© 2001 Data Collection Ltd.

12.3 CALCULATING ANGLE OF ROAD TO TPL/VEHICLE

12.3.1 Introduction

There are two basic methods for calculating the angle of the road to the TPL:

- **Regression:** uses the elevation profile from the TPL; or,
- **Elevations:** uses difference in sensor elevations.

A third method, correlation of gyro readings, does not require the TPL. It is described in Section 12.4. The setup of all methods is described in Section 5.4.8

12.3.2 Regression

The angle of the TPL to the road (θr) is calculated by by performing a regression on the points from the transverse profile data. An example of this from the ROMDAS measurements is given in Figure 12.5. This resulted in the equation:

$$Y = -0.0145 X + 29.767$$

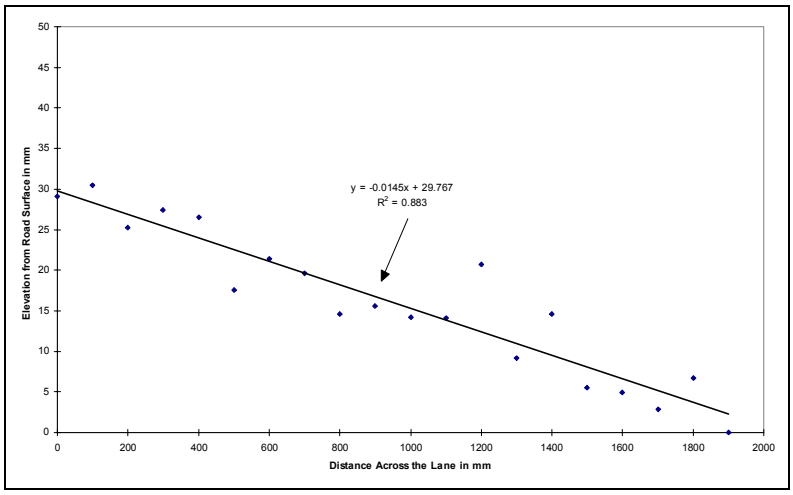


Figure 12.5: Example of Regression Analysis

The tan of the angle is calculated from the constant and the width of the measurements (in this example 1900 mm). From this, θr is calculated:

$$\tan(\theta r) = 29.767/1900 = 0.01599$$

$$\theta r = \text{atan}(0.01599) = 1.15 \text{ degrees}$$

Assuming that the slope of the bar to the horizontal is 1.50 degrees, the crossfall is calculated as:

$$\theta c = \theta r + \theta h = 1.15 + 1.50 = 2.65 \text{ degrees}$$

This method works best on pavements with a regular profile across the lane. It will give spurious results when used with highly irregular pavements, such as are illustrated in Figure 12.6.

© 2001 Data Collection Ltd.

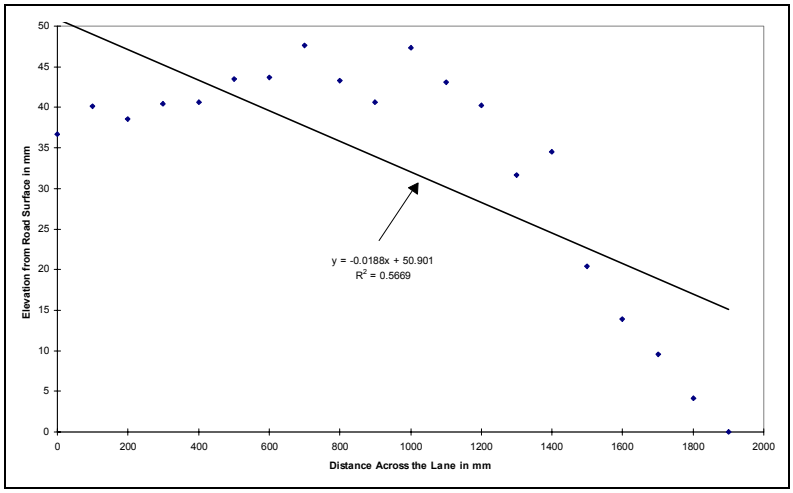


Figure 12.6: Example of Irregular Pavement

12.3.3 Elevations

The 'Elevations' method uses the differences in the elevations between two sets of sensors for the calculations. The user can define up to three sensors in either the wheelpath or at the edge to calculate an average elevation at a point under the TPL. The difference in the elevations is used to calculate the angle of TPL to the road.

12.4 ROLL CALIBRATION

The roll calibration method does not require the TPL to be used. It consists of operating the vehicle on a series of roads with different crossfalls. A regression equation is developed which expresses the crossfall as a function of the ROMDAS roll gyro readings.

It must be recognised that this method will only give an approximation of the crossfall and will be influenced by factors such as horizontal alignment and roughness.

© 2001 Data Collection Ltd.

13. GPS SURVEYS

13.1 INTRODUCTION

ROMDAS is able to record Global Positioning System (GPS) data during any of its surveys. The system is designed to work with a range of GPS receivers and the data recorded will depend upon the type of receiver.

The capabilities—and limitations—of the GPS measurements depend upon both the receiver and the GPS system itself. This chapter provides basic background to GPS as well as applying it in surveys.

13.2 OVERVIEW OF GPS

The Navigation Satellite Timing and Ranging (NAVSTAR) GPS is a space-based satellite radio navigation system developed by the U.S. Department of Defence. There are a series of 24 satellites placed in 6 orbital planes about 20,200 km above the earth's surface. The satellites are in circular orbits with a 12-hour orbital period and inclination angle of 55 degrees. This orientation normally provides a GPS user with a minimum of five satellites in view from any point on Earth at any one time.

Each satellite continuously broadcasts a radio frequency signal. To determine a range, the GPS receiver measures the time required for the GPS signal to travel from the satellite to the receiver antenna. The timing code generated by each satellite is compared to an identical code generated by the receiver. The receiver's code is shifted until it matches the satellite's code. The resulting time shift is multiplied by the speed of light to arrive at the apparent range measurement.

Since the resulting range measurement contains propagation delays due to atmospheric effects, and satellite and receiver clock errors, it is referred to as a "pseudorange". Changes in each of these pseudoranges over a short period of time are also measured and processed by the receiver. These measurements, referred to as "delta-pseudoranges" are used to compute velocity.

A minimum of four pseudorange measurements are required by the receiver to mathematically determine time and the three components of position (latitude, longitude, and altitude). Figure 13.1 shows how three satellites are used to establish position. This figure does not include the fourth timing satellite.

After the four range equations are solved, the receiver has estimates of its position and time. Similar equations are then used to calculate velocity using the relative velocities instead of pseudoranges. The position, velocity and time data are generally computed once per second.

© 2001 Data Collection Ltd.

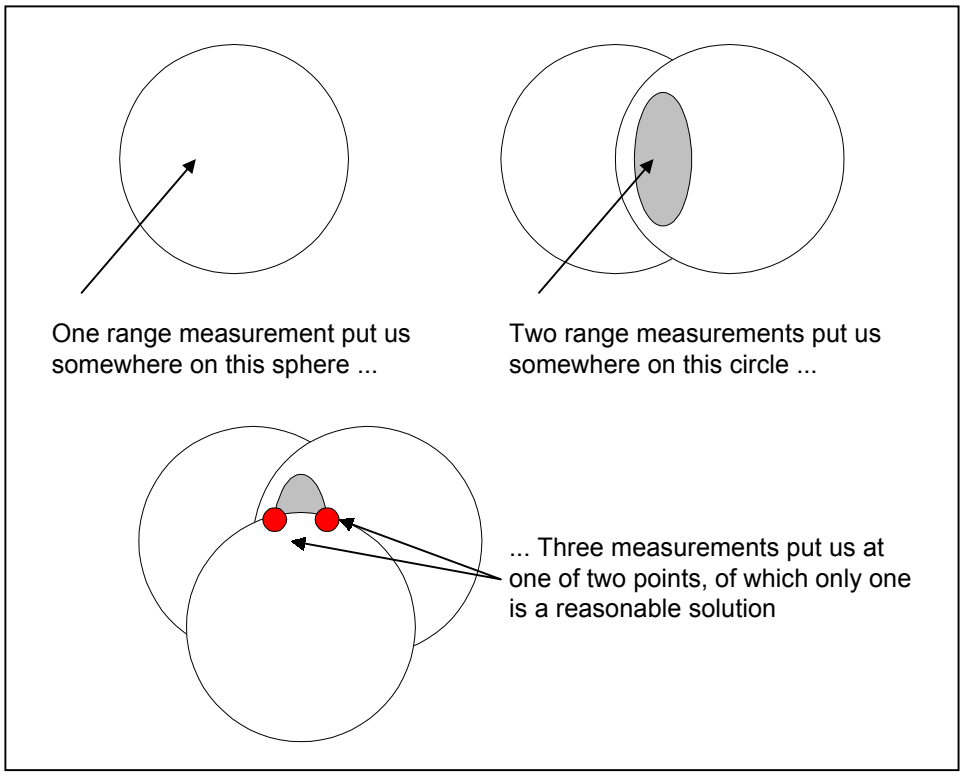

One range measurement put us somewhere on this sphere ...
Two range measurements put us somewhere on this circle ...
... Three measurements put us at one of two points, of which only one is a reasonable solution

Figure 13.1: Satellite Triangulation

13.3 GPS Accuracy

GPS accuracy depends upon two important factors:

- the error in the range measurements; and,
- the geometry or relative positions of the satellites and the user (called 'Dilution of Precision').

The error in the range measurement is dependent on one of two levels of GPS accuracy to which the user has access. Full accuracy is available only to U.S. military applications. A system termed "Selective Availability" (SA) is used to dilute the precision of GPS and it is this reduced accuracy which is available to civilian applications. Differential GPS (DGPS) is used to correct for certain bias-type errors in the civilian GPS signals, and this is discussed later.

The dilution of precision (DOPs) has the following components:

- **GDOP** - Geometric Dilution of Precision: the extent that the geometric relationship of the tracked satellites affects the estimate of the receiver's position, velocity and time;
- **HDOP** - Horizontal Position DOP;
- **VDOP** - Vertical Position DOP;
- **PDOP** - Position DOP; and,
- **TDOP** - Time DOP.

DOPs are computed based on the spatial relationships of the lines of sight between the satellites and the user. The motion of the satellites relative to each other and the user causes the DOPs to vary constantly. For the same range measurement errors, lower DOPs relate to more accurate estimates. The errors in the range measurements used to solve for the position may be magnified by poor geometry. The least amount of error results when the lines of sight have the greatest angular separation between them (see Figure 13.2).

© 2001 Data Collection Ltd.

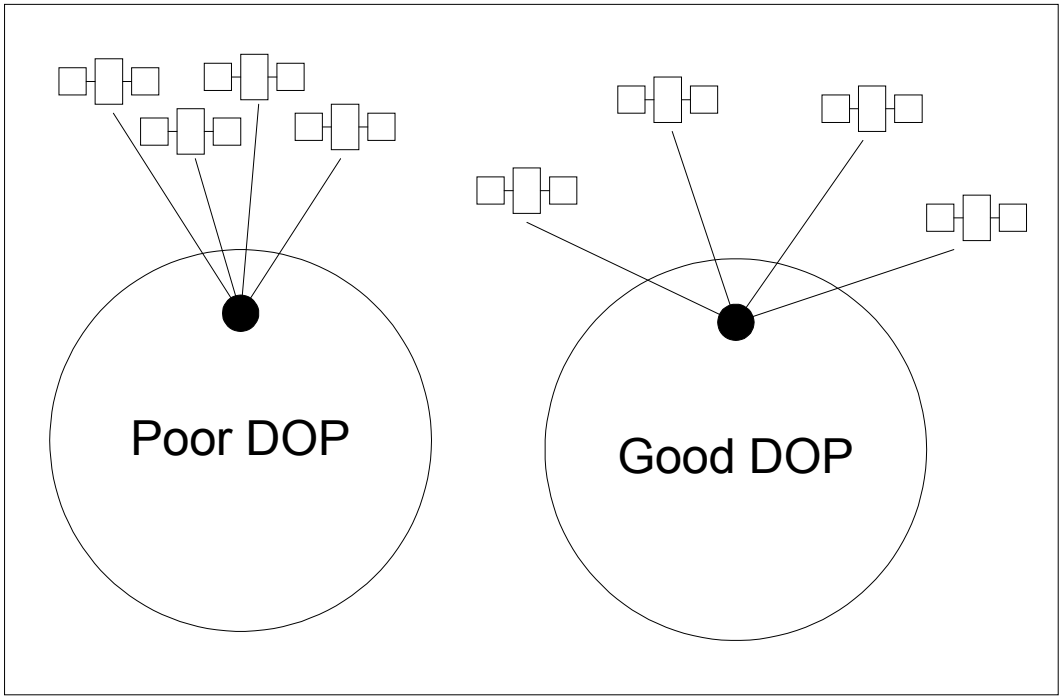


Figure 13.2: Geometrical Dilution of Precision

Differential GPS uses data from a Reference Station receiver to correct for errors in the field survey receiver. The basic approach is that there is a receiver with a **known** location—in effect, a static reference point. The differences in the location of this station calculated from the GPS signals is used to establish corrections for the field receivers. These corrections can be transmitted in real time using radio signals or even cellular phones, or the field data can be post-processed to correct for errors. This is done via time synchronisation between the base station and field survey receiver. The base station must usually be within about 250 km of the field receiver for accurate results.

Table 13.1 summarises the estimated error reduction when using DGPS as opposed to standard GPS.

Table 13.1: Standard vs Differential GPS Errors

Source of Error	Typical Error Budget in m	
	Standard GPS	Differential GPS
Per Satellite Accuracy		
Satellite Clocks	1.5	0.0
Orbit Errors	2.5	0.0
Ionosphere	5.0	0.4
Troposphere	0.5	0.2
Receiver Noise	0.3	0.3
Multipath (Reflections)	0.6	0.6
Typical Position Accuracy		
Horizontal	15.0	<= 1.3
Vertical	78.0	2.0
3-D	93.0	2.8

Source: Differential GPS Explained. Trimble Navigation (1993). The values for selective availability have been deleted and the standard GPS accuracy adjusted.

© 2001 Data Collection Ltd.

13.4 ROMDAS GPS MEASUREMENTS

The ROMDAS GPS measurements are **entirely** based on the GPS receiver that is used. The GPS receiver performs all the GPS calculations and, if it is able, the real-time differential corrections. The receiver then transmits these data to ROMDAS where it is stored with the other survey data.

Depending upon the receiver, ROMDAS will perform a variety of data checks. Most receivers have an initialisation period called the 'Acquisition Mode'. In this mode the data from the satellites are analysed to establish the initial position. It is best if the vehicle is stationary and has a clear view of the sky. ROMDAS will wait until the data are of sufficient accuracy—as defined by the receiver—before initialising for the GPS survey. If sufficient accuracy is not obtained the user should not record GPS data in the survey. ROMDAS gives the option of carrying out the survey without waiting for valid data.

Box 13.1 Real Time Corrections

In many locations there are marine beacons which transmit a real-time differential correction signal. If the receiver is designed to use these signals, the GPS measurements will be received and stored by ROMDAS already differentially corrected.

ROMDAS also works with the Omnistar system to provide real-time corrected GPS measurements. This service, which operates its own satellites and base stations, eliminates the need for your own base stations and post-processing. The user subscribes to the Omnistar signal and all data are corrected in real-time. Details on Omnistar and the coverage are available from www.omnistar.com.au.

The user can define the interval where ROMDAS will query the GPS receiver for its data. The minimum time is once per second. ROMDAS will display the latitude, longitude and altitude positions on the screen and these, along with other salient data, will be stored in the data files.

Since each GPS receiver manufacturer has its own proprietary format, it is necessary to ensure that ROMDAS is able to support the receiver. All receivers supplied by DCL Ltd. work with ROMDAS. Other receivers can be customised for use with ROMDAS. The receivers currently installed with ROMDAS are listed in Section 5.6.11. However, since NMEA is supported by most manufacturers there should not be a problem interfacing with ROMDAS.

It should be noted that the ROMDAS GPS survey option is not included in the standard ROMDAS system. An additional fee must be paid to access this feature.

13.5 GPS Data Processing

As shown in Figure 13.3, ROMDAS contains routines for integrating the GPS survey data with differentially corrected data. In addition, it will optionally perform additional processing, such as averaging readings when a vehicle is stationary.

The differentially corrected routines are important since this gets around the inherent limitations in GPS accuracy. The routines are predicated on the data being logged simultaneously with the GPS receiver's own data logger and corrected using base station data using the receiver's own software. This results in a file which contains highly accurate latitude, longitude and altitude data. These data are used to replace the data measured with the ROMDAS survey.

© 2001 Data Collection Ltd.

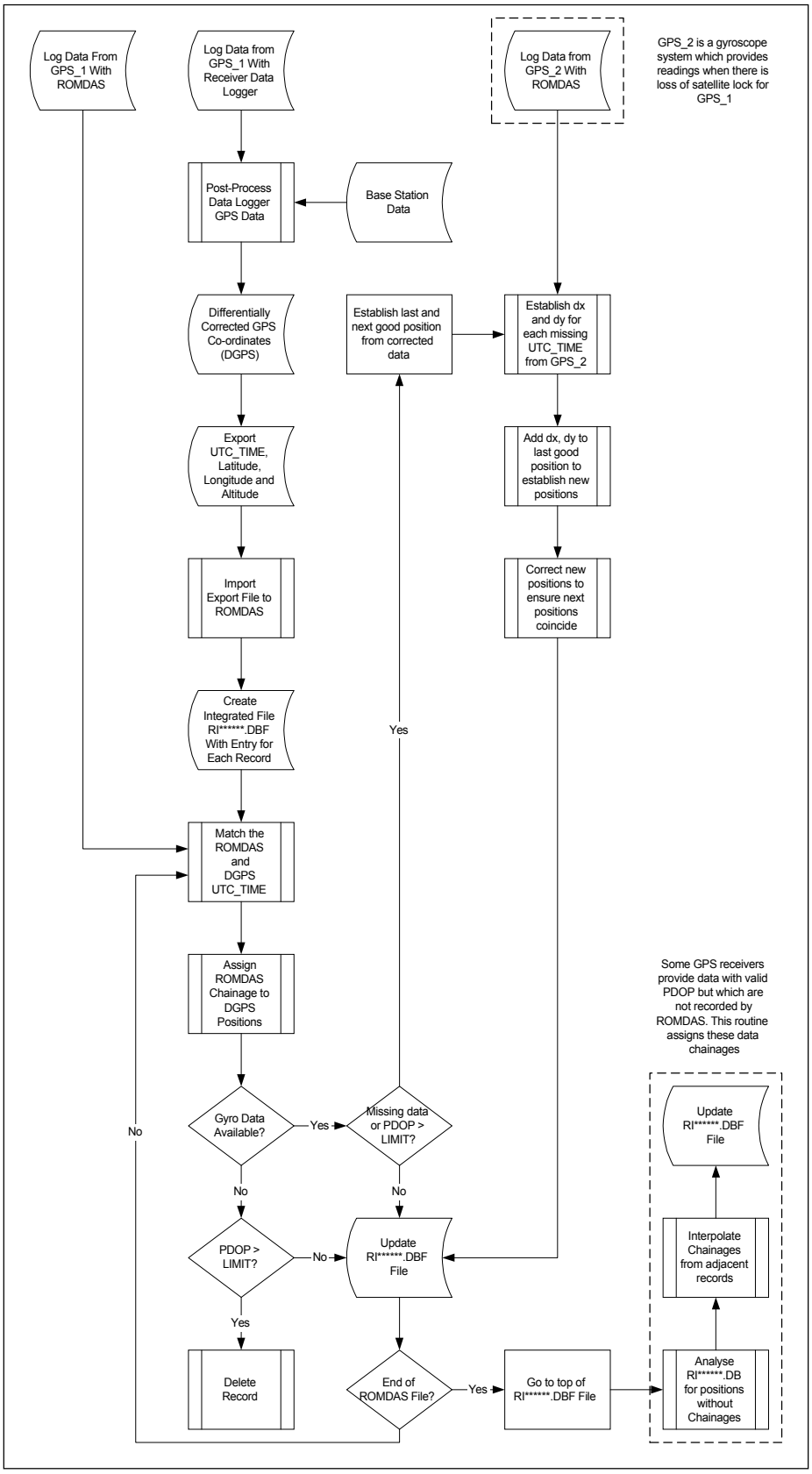

Log Data From GPS_1 With ROMDAS
Log Data from GPS_1 With Receiver Data Logger
Log Data from GPS_2 With ROMDAS
GPS_2 is a gyroscope system which provides readings when there is loss of satellite lock for GPS_1
Post-Process Data Logger GPS Data
Base Station Data
Differentially Corrected GPS Co-ordinates (DGPS)
Establish last and next good position from corrected data
Establish dx and dy for each missing UTC_TIME from GPS_2
Export UTC_TIME, Latitude, Longitude and Altitude
Add dx, dy to last good position to establish new positions
Import Export File to ROMDAS
Correct new positions to ensure next positions coincide
Create Integrated File RI******.DBF With Entry for Each Record
Yes
Match the ROMDAS and DGPS UTC_TIME
Assign ROMDAS Chainage to DGPS Positions
Some GPS receivers provide data with valid PDOP but which are not recorded by ROMDAS. This routine assigns these data chainages
Gyro Data Available?
Yes
Missing data or PDOP > LIMIT?
No
Update RI******.DBF File
No
PDOP > LIMIT?
No
Update RI******.DBF File
Interpolate Chainages from adjacent records
Yes
Delete Record
End of ROMDAS File?
Yes
Go to top of RI******.DBF File
Analyse RI******.DB for positions without Chainages

Figure 13.3: ROMDAS GPS Data Processing

© 2001 Data Collection Ltd.

The differentially corrected data must be given the same file name as the ROMDAS GPS file, but with the prefix DC. For example, if the ROMDAS data were stored to the file SH30, the file names would be RRSH30.DBF (roughness), RGSH30.DBF (GPS) and RKSH30.DBF (Keycode). The differentially corrected data would have to be stored in the file DCSH30.DBF. This file must be placed in the sub-directory POSTPRO under GPS (see Figure 4.1).

The file must have the following structure:

ID	N*5	GPS receiver ID
Latitude	N*15.6	Latitude
Longitude	N*15.6	Longitude
Height	N*13.3	Altitude
GPS_TIME	C*14	GPS Time

The GPS_TIME can be either the local GPS time or the UTC_TIME. If local GPS_TIME the offset must be defined in the data processing setup.

To process the data the user selects **DATA MANAGEMENT|GPS DATA|PROCESS GPS DATA**. They are then presented with a list of the raw ROMDAS files (RG******.DBF) to process.

13.6 GPS Laser Surveyor

The ROMDAS Laser Survey is used to establish accurate GPS co-ordinates of roadside events. It consists of a hand held laser distance measurement device with an integrated compass and inclinometer. These are used to take a 'shot' of the event and the data is recorded by ROMDAS in the data file. These data are used with the GPS co-ordinates to obtain a precise location of the event. When coupled with digital photos this offers an excellent way of obtaining the detailed locations of the events.

ROMDAS will work with the Laser Technologies and Laser Atlanta systems. It can also be customised to work with other products. The photo below shows the Laser Atlanta Advantage.

Figure 13.4: Laser Advantage Laser Surveyor

The measurements are taken by stopping the vehicle and taking a measurement with the Laser Surveyor. As shown earlier in Figure 9.2, the Laser Surveyor transmits the distance, bearing and azimuth to ROMDAS.

© 2001 Data Collection Ltd.

The Laser Surveyor data is used with the vehicle's GPS co-ordinates to determine the GPS co-ordinates of the event. This is done using the following approximate solution:

$$\phi_2 = \phi_1 + \frac{S.\cos\alpha}{R}.\frac{180}{\pi} = \phi_1 + k.S.\cos\alpha$$

$$\lambda_2 = \lambda_1 + \frac{S.\sin\alpha}{R.\cos\phi_1}.\frac{180}{\pi} = \lambda_1 + k.\frac{S.\sin\alpha}{\cos\phi_1}$$

where ϕ_1 is the latitude of the ROMDAS GPS in degrees
λ_1 is the longitude of the ROMDAS GPS in degrees
ϕ_2 is the latitude of the roadside event in degrees
λ_2 is the longitude of the roadside event in degrees
S is the horizontal distance to the event in m
α is the bearing to the event in degrees
R is a mean radius of curvature for the WGS84 ellipsoid (6371000m)
$k = \frac{180}{\pi R}$ = 0.000008993 for the WGS84 ellipsoid

For distances less than 20 m, the error in the position of the second point due to using the mean radius R instead of the actual radius M (which is a complicated function of the latitude) will be less than 10cm.

These equations are valid under the following assumptions:

- distances are less than 20 m;
- distances are horizontal; and,
- bearings are measured clockwise from true North.

NOTE: Some vehicles cause interference with the digital compasses in the laser units. They should be tested and calibrated as per the manufacturer's instructions. The accuracy of the results are entirely dependant on the data transmitted by the laser unit.

© 2001 Data Collection Ltd.

14. SKID RESISTANCE SURVEYS

14.1 INTRODUCTION

ROMDAS is able to measure skid resistance at the same time as collecting data from its other surveys. The system is currently designed to work with the Findlay Irvine GripTester[1], although it will work with any other skid resistance instrument which has a serial data protocol.

The GripTester is a small trailer which operates on fixed slip principles. The measuring wheel has a slip percentage of 18% which is used to calculate the Grip Number. From this, the SCRIM number can also be calculated. Figure 14.1 shows the GripTester being towed.

Figure 14.1: Findlay Irvine GripTester

14.2 USING THE GRIPTESTER IN A SURVEY

In order to use the GripTester it must first be setup as described in Section 5.6.12. Once setup, this will give the operators the option to specify use of the GripTester in any of the survey menus.

If the operator indicates that a GripTester will be used in the survey, they will be presented with an additional input screen to enter specific data pertaining to the GripTester survey. This screen is illustrated in Figure 14.2.

The data entries are the same as those used by the GripTester with its own software and users should refer to the GripTester manual for details on these entries.

[1] The GripTester is manufactured by Findlay, Irvine Ltd., Bog Road, Penicuik, Midlothian, EH26 9BU, Scotland, UK. Tel: +44-1968-672-111; Fax: +44-1968-672-596. Those interested in details on the GripTester should contact Findlay, Irvine Ltd. The Danish Road Institute Report 82 is another good source. This compares the GripTester with the Norsemeter ROAR and the Stadograf on the same sections. Copies are available from the Danish Road Directorate at Fax: +45-46-30-01-05.

© 2001 Data Collection Ltd.

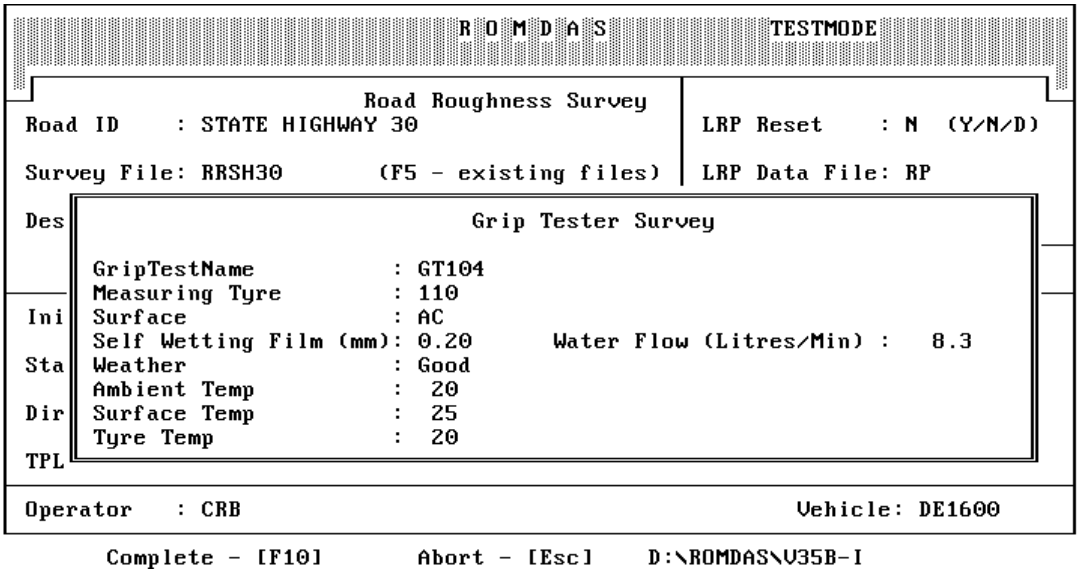

R O M D A S TESTMODE
Road Roughness Survey
Road ID : STATE HIGHWAY 30
LRP Reset : N (Y/N/D)
Survey File: RRSH30 (F5 - existing files)
LRP Data File: RP
Des
Grip Tester Survey
GripTestName : GT104
Measuring Tyre : 110
Ini Surface : AC
Self Wetting Film (mm): 0.20 Water Flow (Litres/Min) : 8.3
Sta Weather : Good
Ambient Temp : 20
Dir Surface Temp : 25
Tyre Temp : 20
TPL
Operator : CRB
Vehicle: DE1600
Complete - [F10] Abort - [Esc] D:\ROMDAS\V35B-I

Figure 14.2: GripTester Survey Data Entry Screen

During the survey ROMDAS records the data stream from the GripTester on a continuous basis and stores the data in 10 m intervals. The operator is also shown the 100 m average Grip numbers on the survey screen.

There is an important difference between the ROMDAS GripTester implementation and that used with the standard GripTester software that the user must be aware of and it has to do with location referencing. The GripTester is normally operated without any form of location reference point (LRP) resets. The data are stored in 10 m intervals continually from the start of the road. As explained in Chapter 2 of this manual, it is recommended that instead of accumulating distance continually that the chainage be reset to 0 at regular location reference points. This serves to reduce the cumulative error and also to facilitate reconciling data between successive surveys.

Box 14.1 GripTester Distance Measurement

To ensure that the ROMDAS and GripTester measurements are fully reconciled it is recommended that the GripTester distance measurement instrument be used to also drive the ROMDAS system. This is done using a special cable which is available from DCL or Findlay Irvine Ltd which plugs into the ROMDAS hardware interface from the GripTester.

When the GripTester is used with other ROMDAS surveys it is used in this mode, *i.e.* with the chainage being reset at LRPs. This makes its data fully compatible with those from the other ROMDAS surveys. In practical terms this should make little difference given the 10 m default sampling interval of the GripTester using its own software.

14.3 DATA PROCESSING

The GripTester data is calculated using the same data processing routines as with the standard GripTester software. Specifically:

© 2001 Data Collection Ltd.

- The Grip Number is calculated as ABS(TRUNC(Raw Data/100)*1.2/255)
- The SCRIM number is calculated as 0.789*Grip Number - 0.049, where 0.789 is the SCRIM constant and -0.049 is the slope. These values are defined under the GripTester setup as described in Section 5.6.12.

© 2001 Data Collection Ltd.

15. MOVING TRAFFIC SURVEYS

15.1 Introduction

Traffic count data have always been recognised as important in the design and planning process. Traditionally, most traffic count data have come from temporary or permanent traffic count locations. Either manual or automatic surveys are done which count the number of vehicles and convert these to an average daily traffic (ADT) or the average annual daily traffic (AADT).

An alternative approach, which lends itself to a ROMDAS survey, is to do a 'Moving Traffic Count'. It works mainly on single and two-lane roads, although theoretically it should also work on multi-lane roads.

To calculate the ADT from a moving vehicle, consider the following proof[1] where:

- X is the oncoming flow rate in veh/h
- So is the average oncoming vehicle speed in km/h
- Sr is the speed of the ROMDAS survey vehicle in km/h
- L is the distance travelled by the ROMDAS survey vehicle in km
- C is the number of vehicles counted travelling in the opposite direction in veh

The average headway (km/veh) between vehicles is So/X. The length of the observed traffic stream (in km) is C So/X.

The observed duration of the survey (in h) is given by L/Sr. Hence the length (km) of the traffic stream that has been observed is (Sr+So) L/Sr.

Equating these two expressions:

$$X = C\,So/[(Sr + So)\,L/Sr]$$

$$X = \frac{C}{L}\frac{1}{\frac{1}{So}+\frac{1}{Sr}}$$

If the survey vehicle travels at the same speed as the oncoming traffic, and it is assumed that there are no speed differences between classes, the above expression reduces to:

$$X = \frac{C}{L}\frac{Sr}{2}$$

Since the duration of the survey is given by t = L/Sr, this can be expressed as:

$$X = \frac{C}{2\,t}$$

We assume that the ADT is twice the flow in the opposing direction so the ADT is given as[1]:

[1] The author would like to acknowledge the assistance of Dr. R.R. Allan with this proof (ron@ron.org).

© 2001 Data Collection Ltd.

$$ADT = \frac{C}{t}$$

Or, for different survey vehicle speeds to oncoming traffic:

$$ADT = \frac{C}{L}\frac{2}{\frac{1}{So}+\frac{1}{Sr}}$$

The accuracy of the ADT count can be improved by classifying the vehicles and using the above expression to calculate the ADT by class and added to get the total ADT. It is not necessary to have the precise speeds of these other vehicle classes in the calculations. The speeds for the buses and trucks can be expressed relative to car speeds, for example as travelling 10 and 20 km/h slower respectively:

$$ADTpc = \frac{Cpc}{L}\frac{2}{\frac{1}{So}+\frac{1}{Sr}}$$

$$ADThb = \frac{Chb}{L}\frac{2}{\frac{1}{So-10}+\frac{1}{Sr}}$$

$$ADTtk = \frac{Ctk}{L}\frac{2}{\frac{1}{So-20}+\frac{1}{Sr}}$$

$$ADT = CFadt\ (ADTpc + ADThb + ADTtk)$$

where CFadt is the ADT calibration factor based on time of day

How reliable is this method at calculating the ADT? Figure 15.1 shows the results of AADT derived from moving survey data from India, corrected for time of day and other factors, compared to the AADT from 7-day counts for the same road sections[2]. It can be observed that the moving survey method gave an excellent correlation with the 7-day counts.

At present, it is necessary to record the traffic manually. However, an automatic system is currently under development for use with ROMDAS which will identify when a vehicle is passes the survey vehicle.

---

[1] An alternative approach is proposed by the TRL. They use the equation ADT = (C + y – z)/t where y is the number of vehicles that overtake the survey vehicle (Direction = 1) and z is the number of vehicles overtaken by the survey vehicle (Direction = 2). The theoretical basis for this equation is not known but it is postulated it is to correct for a departure from the median speed by the survey vehicle. The user can optionally apply this equation in processing survey data collected with ROMDAS, but it is recommended that the ROMDAS method described above be used.

[2] Bennett, C.R. and Paterson, W.D.O. (1999). *HDM Calibration Reference Manual*. Report to the International Study of Highway Development and Management Tools, PIARC, Paris.

© 2001 Data Collection Ltd.

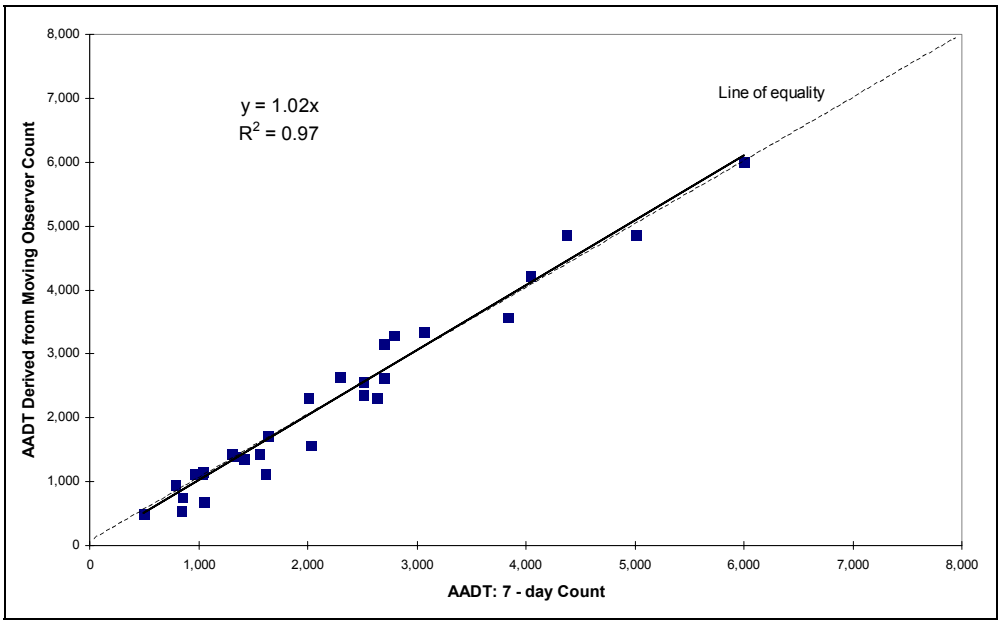


Figure 15.1: Example of Moving vs 7-Day ADT from India

15.2 Setting Up ROMDAS For Moving Traffic Counts

To set up ROMDAS for moving traffic counts the keycode event file (see Section 5.3.1) must have certain keys assigned to traffic count keys. This is done by changing the field "Vehicle" from F to T. Optionally, or if you are using the TRL analysis method, you can define the direction as 0, 1, 2: 0 is the opposite direction; 1 is a vehicle which overtakes the ROMDAS survey vehicle; 2 is a vehicle overtaken by the ROMDAS survey vehicle. It is also useful to define the relative speeds of the vehicles so that the ADT is correctly calculated.

An example of how one might set up the data for the keycode event file is as follows:

Key	Direction	Relative Speed	Vehicle
A	0	0	Car
B	0	-10	Bus
C	0	-20	Truck
D	1	0	Car
E	1	-10	Bus
F	1	-20	Truck
G	2	0	Car
H	2	-10	Bus
I	2	-20	Truck

The other information required is conversion factors for the moving count to ADT values. To illustrate how this is done, consider Figure 15.2 which shows the hourly flows (veh/h) over a 24 h period based on 5 minute intervals for a motorway in Bangkok. The direction monitored was out of town so the flows are low during the morning peak and increase during the day, reaching their highest during the afternoon peak.

© 2001 Data Collection Ltd.

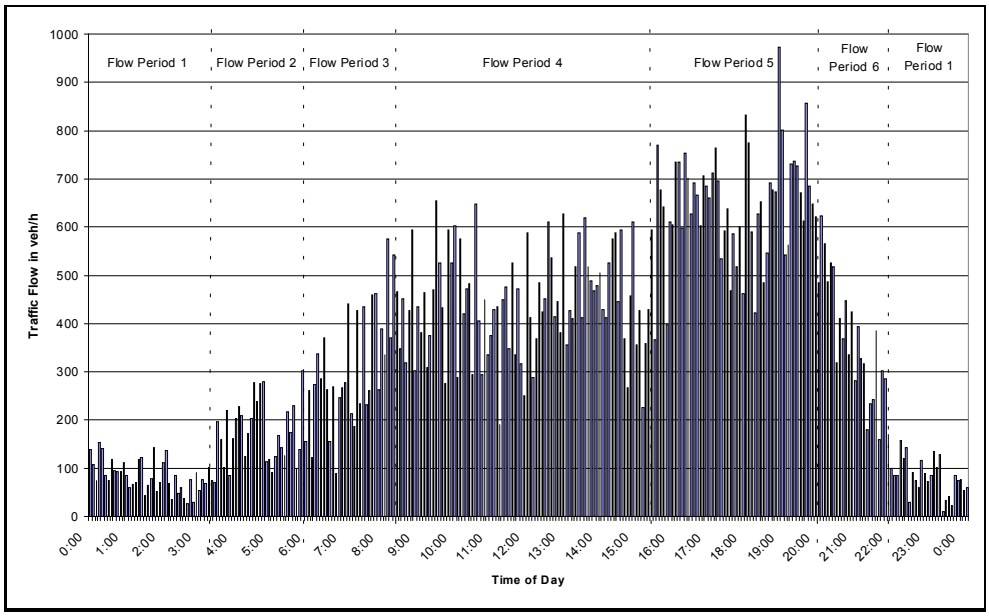


Figure 15.2: Example of Daily Flow Profile

On the basis of the flows, six periods with relatively constant flow were identified. The flows during these periods are given in the table below. Dividing the flow by the length of each period gives the average hourly flow in veh/h. The total number of vehicles observed (ADT) was 8076. The adjustment factor for each of the flow periods is therefore given by the ADT divided by the hourly flow. These are given in the right column. Thus, an hourly flow measured between 06:00 and 08:30 should be multiplied by 28 to convert it to an ADT.

Start	End	Observed Flow (vehicles)	Hourly Flow (veh/h)	Adjustment Factor to ADT
22:00	03:30	389	71	114
03:30	06:00	398	159	51
06:00	08:30	733	293	28
08:30	15:30	2986	427	19
15:30	20:00	2857	635	13
20:00	22:00	713	357	23
	ADT	8076		

It should be noted that the flow profiles are dependent upon the type of road being surveyed. As a general rule, they will be different for urban and rural roads, and different roads in your hierarchy (*eg* residential, collector and arterial).

The ADT also needs to be converted to an AADT using correction factors which are based on the month of year and, optionally, the day of week. Figure 15.3 is an example of AADT seasonal correction factors from Gujarat, India. The traffic flows are lowest during the monsoon season from June-September so counts taken during these periods are multiplied by a factor greater than 1 to convert them to an AADT.

© 2001 Data Collection Ltd.

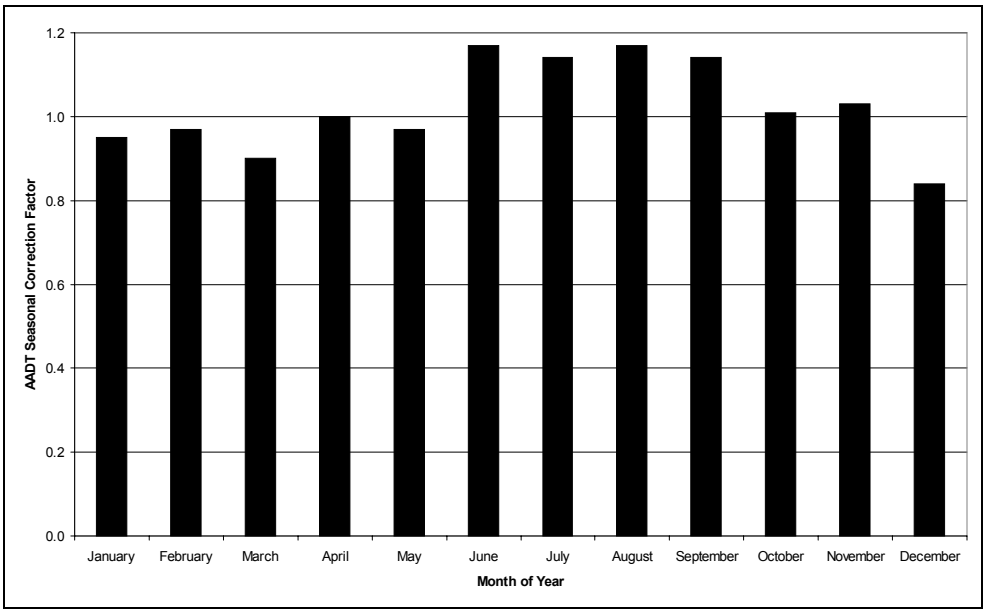


Figure 15.3: AADT Seasonal Correction Factors from Gujarat, India

The conversion is done as:

$$AADT = CF_{aadt}\ ADT$$

where CF_{aadt} is the AADT seasonal correction factor

The user must define the ADT and AADT correction factors in ROMDAS and these are used in converting the moving traffic count data to an AADT.

15.3 Executing a Moving Traffic Survey

Once the system has been set up with keys assigned to record traffic data, the moving traffic survey is done by having the operator press a key when a vehicle travelling in the opposite direction is passed[1].

When a key is pressed the time of observation is stored in the data file along with the vehicle class and the key pressed. These data are then used to calculate the AADT.

Box 15.1 Using a Mouse

Moving traffic surveys are ideally suited to using a three button mouse to record the data. The mouse buttons can be assigned to the car, bus and truck classes and these are pressed when a vehicle travelling in the opposite direction is passed. It may be possible to have the driver collect these data as long as the volumes are not too high. See Section 5.5.3 for details on assigning keys to mouse buttons.

[1] It the TRL method is used it is also necessary to record vehicles overtaken by the survey vehicle or overtaking the survey vehicle.

© 2001 Data Collection Ltd.

15.4 DATA PROCESSING

The traffic count data are processed using the method presented earlier to calculate first the ADT and then the AADT. These data are stored in the output file along with the raw data and the calibration factors. If the traffic survey spans more than one time interval with the ADT factors, the results are weighted based on the length of time in each interval.

© 2001 Data Collection Ltd.

16. DIGITAL ODOMETER

The odometer selection allows the PC to be used as a digital odometer. It is designed to replicate a dual display trip meter.

Selecting this option presents the user with the odometer data input screen. For the top and bottom counters the user can enter two items of data:

- **initial chainage:** This is the chainage to start the display at. The values can be entered for the top or bottom counters.
- **start recording:** The chainage to start recording at. Different values can be entered for the top and bottom counters.

For example, one may be 1000 m from the beginning of the road and wish to use this as the initial chainage. By setting this value as the initial chainage the display would start at 1000 and increment upwards. If you then set the start recording to 1200 m, the display would begin updating after 200 m.

When these data have been entered, the F10 key should be pressed.

The vehicle should be positioned at the start of the section. The user then has the option of pressing the SPACE bar to start the top counter, or the F1 key to start both. Figure 16.1 is an example of the display with this option.

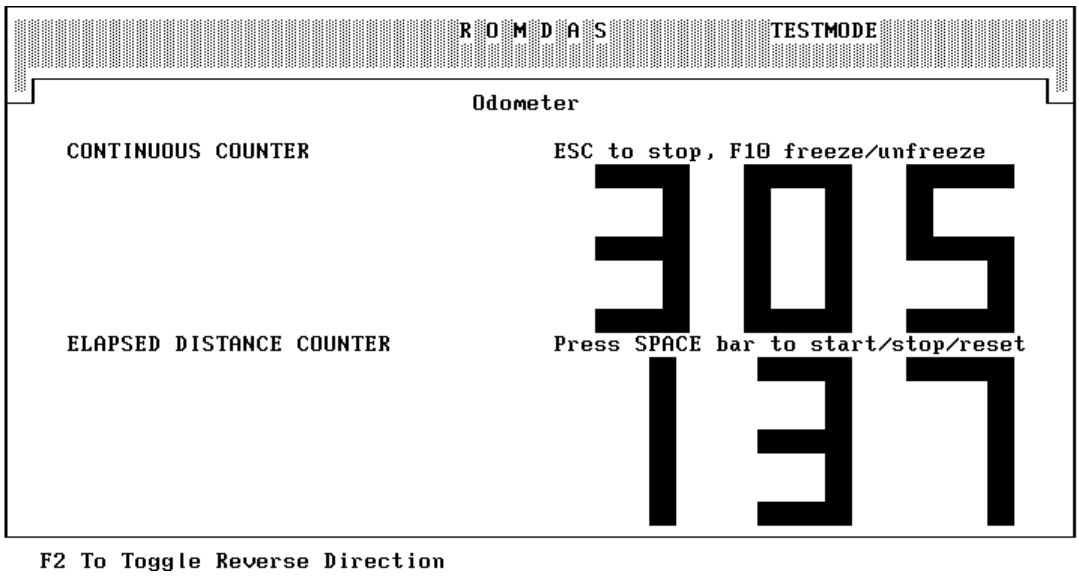


Figure 16.1: Digital Odometer Display

The top and bottom counters are controlled independently. Pressing the F10 key will pause the **display** of the top counter. However, even though the display is paused the cumulative distance is still being recorded. Thus, pressing F10 again will return the display to the current cumulative distance. This is useful for noting the distance of events during a survey.

The bottom counter is used to measure the elapsed distance between two points. Pressing the SPACE bar toggles and resets this counter.

© 2001 Data Collection Ltd.

It should be noted that the display is updated by regularly polling the odometer sensor so the accuracy is proportional to the speed of the vehicle. When high accuracy is required it is necessary to travel at a low speed. This applies to any digital distance/speed sensor.

© 2001 Data Collection Ltd.

17. DATA PROCESSING AND FILE MANAGEMENT

17.1 INTRODUCTION

ROMDAS is able to process the data collected in the survey in a number of ways. It will prepare files of the calibrated roughness (corrected for speeds), output the keycode event files, or export all the raw data for processing using other custom written programs. The program can also be customised for users so that it will export data in a format completely compatible with their existing databases. It comes setup to export data to the dROAD database marketed by Deighton & Associates Ltd. of Canada.

The data processing options are accessed via the Data Management option at the opening menu. This results in the screen shown in Figure 17.1.

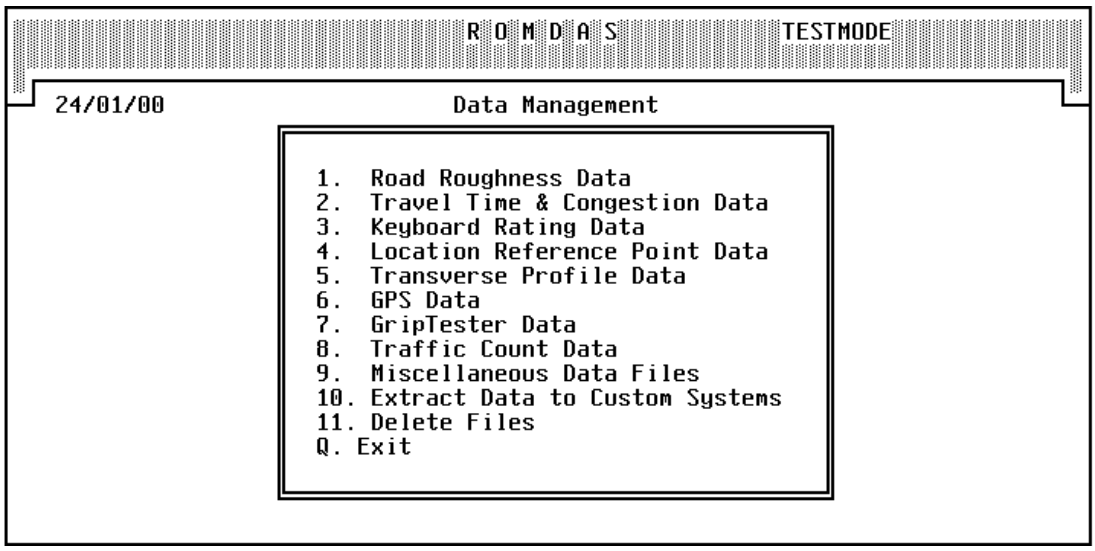


Figure 17.1: Data Management Menu

The data management options are discussed in detail below after an overview of the data file formats.

17.2 DATA FILES

There are a number of different data files associated with ROMDAS. Each type of file is identified by a two letter prefix, as listed in Table 17.1.

The identifier z in the custom database files is a unique identifier for each database. It is set to D for dROAD which is the only database currently installed.

Except for the C* and RL files, the prefixes are followed by the user defined file name. The C* files have a user-defined suffix which should be based on the vehicle number. The RL file uses the survey date as the suffix.

There is also a file called **ROADDAT.DBF**. This is a file which the user can supply the essential data for the survey, such as the road description, LRP name, etc. and have these entered automatically for the operator.

© 2001 Data Collection Ltd.

Table 17.1: ROMDAS Data File Prefixes

Prefix	Contents	Type
AA	AADT seasonal correction factors	Analysis
AD	ADT daily flow profile correction factors	Analysis
CB	Roughness vehicle calibration coefficients	Calibration
CE	Crossfall - edge/wheelpath elevations	Calibration
CR	Crossfall - calibrated roll equation coefficients	Calibration
CT	TPL Calibration Data - Datum Levels	Calibration
DC	Differentially Corrected GPS Data	Raw
GD	GripTester Raw Survey Data	Raw
GH	GripTester Header Data	Raw
GR	GripTester Processed Data	Processed
RA	TPL Calibration Raw Data - Single Measurements	Raw
RB	TPL Calibration Raw Data - Multiple Measurements	Raw
RC	Calibrated roughness survey results	Processed
RD	Road Data: LRP number, chainage, cumulative chainage, and cumulative time for each sampling interval	Log
RE	GripTester Raw Data	Raw
RF	Longitudinal Profile Calibration	Calibration
RG	GPS Raw Data	Raw
RI	GPS Processed Data	Processed
RK	Keyboard rating raw data	Raw
RL	The daily survey log	Log
RM	Master survey file	Log
RO	Moving traffic survey raw data	Raw
RP	Location reference point raw data	Raw
RQ	Moving traffic survey processed data	Processed
RR	Roughness survey raw data	Raw
RS	Speed and acceleration profile data	Processed
RT	Speed survey raw data	Raw
RU	Rut depth and distortion data by profile measurement	Processed
RV	Transverse profile raw data	Raw
RW	Transverse profile converted and standardised profile data	Processed
RX	Crossfall data	Raw
RZ	Elevation profile for IRI calculation	Raw
Sz	Exported section data for custom database	Export
Lz	Exported data item for custom database	Export
PK	Philippines Keycode file	Custom
PL	Philippines LRP file	Custom
PR	Philippines Section file	Custom

All data are stored in dBASE-III compatible files (.DBF). Most relational database files contain a unique field (column) for each record type. However, to conserve file space ROMDAS limits the number of fields and stores different types of data in the records. The field in the first column is called the RECTYPE and this gives the type of data. Table 17.2 defines the RECTYPE values. It should be noted that these are stored as CHARACTER, not numeric, in the database files.

The RECTYPE values are the key to the processing of the ROMDAS data since each are associated with a unique event.

ANNEX M gives examples of the files and their contents.

17.3 ROUGHNESS DATA

The "Roughness Data" menu accesses the options for processing data collected in a road roughness survey. Selecting this option gives the menu shown in Figure 17.2.

© 2001 Data Collection Ltd.

Table 17.2: Description of RECTYPE Values

RECTYPE	Description	Files Used In
1-5	Header data (see below)	All
10	End of roughness sampling interval	Roughness
11	Keycode event	Keycode
12	The measured chainage of an LRP from a manual LRP reset	Roughness Keycode LRP
13	End of sampling interval with excluded bump integrator data (F5)	Roughness
14	Manual pause	Roughness
15	Exclude/Include roughness meter data (F5)	Roughness
16	Intermediate roughness	Roughness
17	The chainage of an LRP from the RPxxxxxx file	Roughness
18	Start LRP	Roughness Speed
19	LRP which is in the RPxxxxxx file but missed during the survey.	Roughness
20	Speed survey data	Speed
21	Rubber banded sampling interval	Roughness

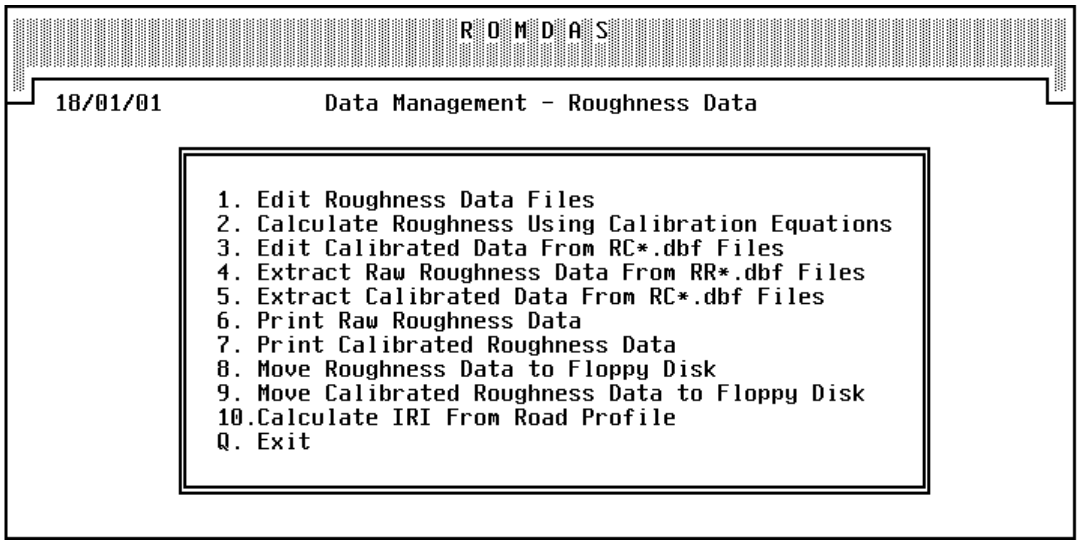

R O M D A S
18/01/01
Data Management - Roughness Data
1. Edit Roughness Data Files
2. Calculate Roughness Using Calibration Equations
3. Edit Calibrated Data From RC*.dbf Files
4. Extract Raw Roughness Data From RR*.dbf Files
5. Extract Calibrated Data From RC*.dbf Files
6. Print Raw Roughness Data
7. Print Calibrated Roughness Data
8. Move Roughness Data to Floppy Disk
9. Move Calibrated Roughness Data to Floppy Disk
10.Calculate IRI From Road Profile
Q. Exit

Figure 17.2: Edit Data Files Menu

17.3.1 Edit Data Files

When selected, a screen shows the existing files along with the activities that can be done to those files. These activities are:

- view; and,
- delete.

The activities are similar for each type of file and are described below.

View

This allows the user to browse and edit the data files. When this option is selected, the user is given a sub-menu such as that illustrated in Figure 17.3. This menu lists the available data.

© 2001 Data Collection Ltd.

The operator can view the section header or the data by highlighting an entry and pressing an S or D.

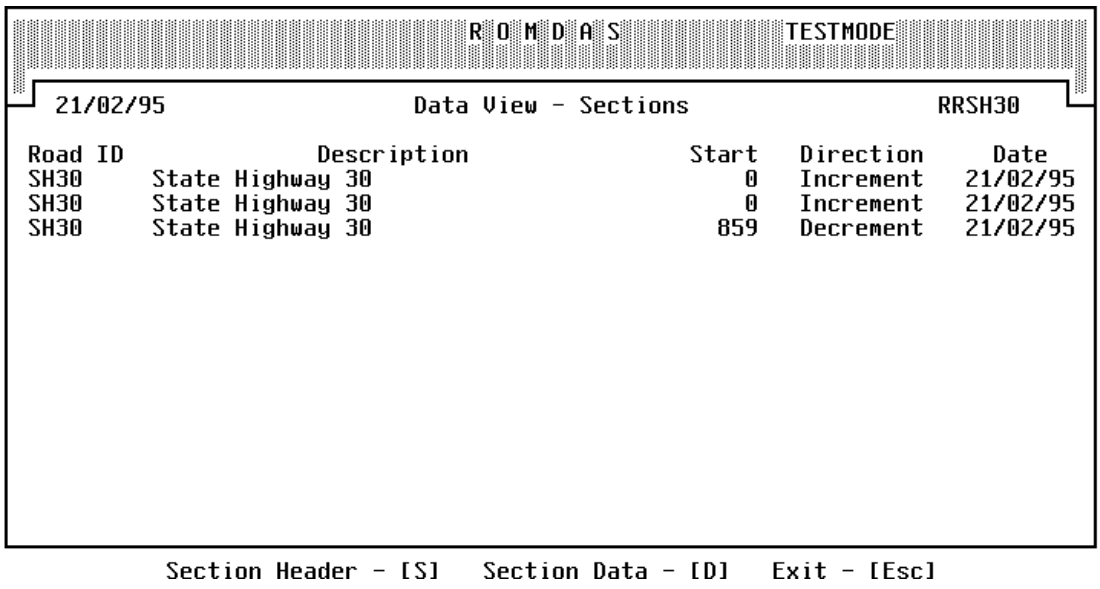

R O M D A S
TESTMODE
21/02/95
Data View - Sections
RRSH30
Road ID Description Start Direction Date
SH30 State Highway 30 0 Increment 21/02/95
SH30 State Highway 30 0 Increment 21/02/95
SH30 State Highway 30 859 Decrement 21/02/95
Section Header - [S] Section Data - [D] Exit - [Esc]

Figure 17.3: File Viewing Menu

The section header contains an assortment of information which applies to the entire survey run. It is almost identical to the initial roughness survey screen (Figure 6.1) but it also includes details on the number of records.

Figure 17.4 is an example of the roughness section data. This file contains the following data:

RECTYPE	The record type
CHAINAGE	The chainage in m from the first LRP
LRP_NUMBER	The LRP number
ROUGH_1	The roughness from BI #1
ROUGH_2	The roughness from BI #2
SPEED	The average speed over the interval in km/h
COMMENT	A user specified comment (not shown in Figure 17.4)

Delete

This option allows the user to delete data files. The number of records in the file is presented and the user is then asked to confirm deletion.

© 2001 Data Collection Ltd.

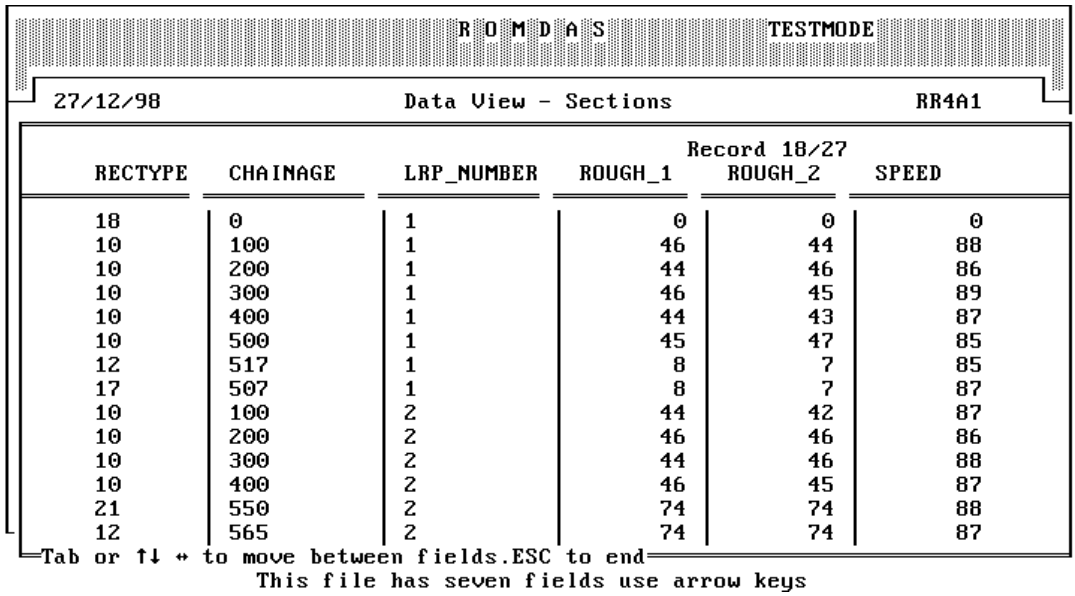


Figure 17.4: Section Data Example

17.3.2 Calculate Roughness Using Calibration Equations

When the user has supplied a series of calibration equations for converting the raw roughness to calibrated roughness (e.g. IRI, 5th Wheel Bump Integrator, etc.), this option will use these equations to convert the raw counts to calibrated roughnesses. ANNEX J discusses in detail calibrating roughness meters.

ROMDAS checks that the vehicle number in the file is the same as that for the vehicle with the calibration coefficients. If it is not, the user is prompted as to whether in fact this calibration file should be used in the calculations.

One of the main problems in obtaining a calibrated roughness is the effect of the survey vehicle operating speed. During roughness surveys it is impossible to maintain a constant speed at all times, particularly if it is a low speed such as the standard 32 km/h recommended with TRL Bump Integrators. Since the conversion between raw roughness and calibrated roughness is usually very sensitive to speed, this means that unless speed is taken into account during the calculations the resulting estimates will be inaccurate.

ROMDAS is designed to circumvent this problem by using the recorded average speed over a sampling interval in conjunction with a calibration equation appropriate for the speed to calculate the calibrated roughness. ROMDAS does this by checking the roughness calibration data file created under the SETUP option, and applying the equation appropriate for the survey speed.

To calculate the roughness you must first identify which equation is to be used. This is because more than one equation may pertain to a vehicle or else you may wish to process data from several surveys by different vehicles. Consequently, the first menu presented lists the available calibration equations. This is illustrated in Figure 17.5.

© 2001 Data Collection Ltd.

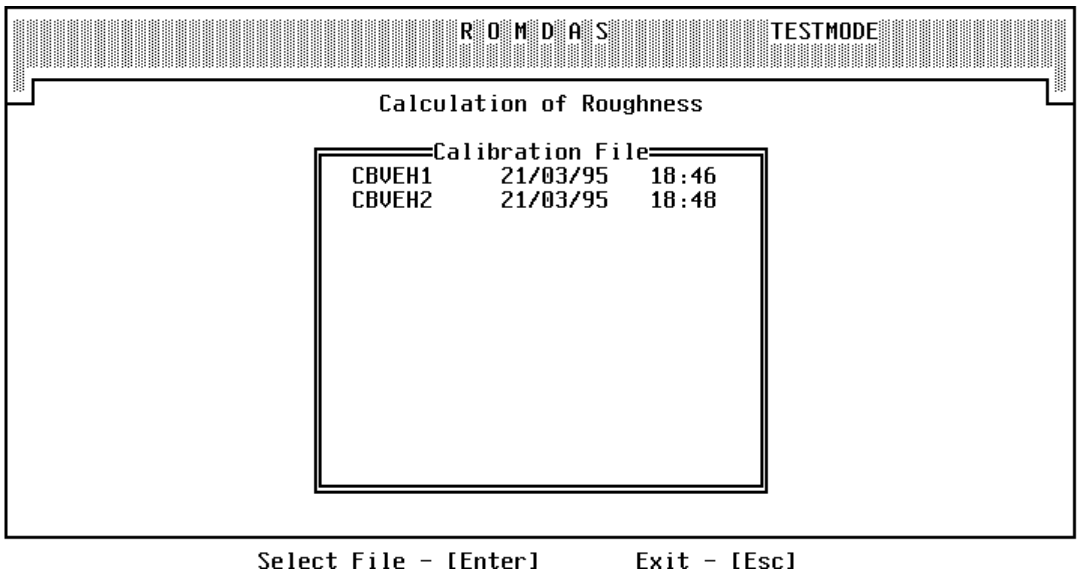


Figure 17.5: Selecting Roughness Calibration Equations

Having selected the appropriate equation, you then select the data file to process from a list of available files. The output will be a file with the chainage, speed, raw and calibrated roughness over the sampling interval. This file has the format shown earlier in Section 17.2.

NOTE: The calibrated roughness is based on the number of counts per km. This means that the raw data is first converted to the number per km based on the measured sampling interval. The calibration conversion equations must therefore also be based on per km measurements for the results to be valid.

When selected, a screen shows the existing files. This option prepares the files with the calibrated roughness. The output file contains the following fields:

CHAIN_FROM	The start chainage of the event
CHAIN_TO	The end chainage of the event
LRP_NUMBER	The LRP number
SPEED	The average speed over the interval in km/h
RAW_C_1	The raw roughness from BI #1 over the interval
RAW_C_2	The raw roughness from BI #2 over the interval
RAW_C_1_KM	The raw roughness from BI #1 over km
RAW_C_2_KM	The raw roughness from BI #2 over km
C_ROUGH_1	The calibrated roughness from BI #1 over km
C_ROUGH_2	The calibrated roughness from BI #2 over km
CALIB_RGH	The average calibrated roughness
QUALITY	The quality of the data

17.3.3 Extract Roughness Data

This option prepares a file with the raw roughness data. These are output in one of the following formats:

D	Variable length, comma delimited files (Data Interchange format). These are ideal for importing into programs such as Lotus 1-2-3.
F	Fixed length "System" format files.

© 2001 Data Collection Ltd.

The first 5 rows of the file contains the header data. These are followed by the actual roughness values as follows:

Column 1	The type of record (RECTYPE)
Column 2	The chainage in m
Column 3	The LRP number
Column 4	The raw roughness counts since the last chainage
Column 5	The speed in km/h
Column 6	Comment

NOTE: The raw roughness data have not been corrected to a per km basis. This must be done based on the elapsed chainage between samples.

17.3.4 Extract Calibrated Roughness Data

This option prepares a Delimited or System file with the calibrated roughness data. The data are:

Column 1	Start chainage of sampling interval in m
Column 2	End chainage of sampling interval in m
Column 3	LRP for sampling interval
Column 4	Speed in km/h
Column 5	Raw roughness counts for sampling interval
Column 6	Raw roughness counts in counts/km
Column 7	Calibrated Roughness

17.3.5 Print Raw or Calibrated Roughness Data

This option prints the raw or calibrated roughness data as an ASCII file. The printing is done through the LPT1: port on the computer. A menu is presented and the file to print is selected.

17.3.6 Move Raw or Calibrated Roughness Data

The move command is used to transfer data files to floppy disk. The user selects the file and is prompted for which floppy drive to transfer the data to (A or B).

ROMDAS is very cautious in its approach to copying data. After copying it checks that the file is readable. It then ensures that the file is of the correct length. If both these criterion are met it will rename the old file .DB0. The user may remove these files using the SETUP menu option 'REMOVE OLD DATA'.

Box 17.1 Problems Deleting Files

It has been found on some computers that the move and delete commands do not work correctly. Please test this command on your computer before using it in the field. In the event that the move command does not work, it is necessary to use the MS-DOS copy command to transfer files. The MS-DOS delete command will need to be used to delete files.

© 2001 Data Collection Ltd.

17.3.7 Calculate IRI From Road Profile

This option is used to calculate the IRI from a road profile elevation file. The method used is from Sayers et al. (1986)[1].

The input file must have the name RZxxxxxx.DBF and contain (at least) two fields: CHAINAGE (N 10.2) and ELEVATION (N 10.1). The CHAINAGE is the spacing between elevation measurements (in m) and the ELEVATION is the elevation of each point (in mm). This file **MUST** be stored in the directory LPL/RAW.

The software checks the spacings between elevations and then establishes the appropriate IRI coefficients from the file IRICOEFF.DBF, which is stored in the ROMDAS directory. The IRI is then calculated from the elevation profile and displayed on the screen.

17.4 TRAVEL TIME AND CONGESTION SURVEY DATA

Figure 17.6 shows the data management for the travel time and congestion survey data. The options are similar to those with roughness surveys with the exception of the profile calculation.

The time, speed and acceleration profile calculation uses the raw data to calculate the average speed as well as the instantaneous speeds and accelerations:

- **average speed**: this is defined as the cumulative distance travelled divided by the cumulative time. When LRPs are used the value represents the average speed between LRPs. It is reported in km/h.
- **instantaneous speed**: the instantaneous speed is the speed over the last observation interval. It is the change in distance divided by the change in time. It is reported in km/h.
- **instantaneous acceleration**: this is calculated as the change in instantaneous speed divided by the change in time. It is reported in m/s^2.

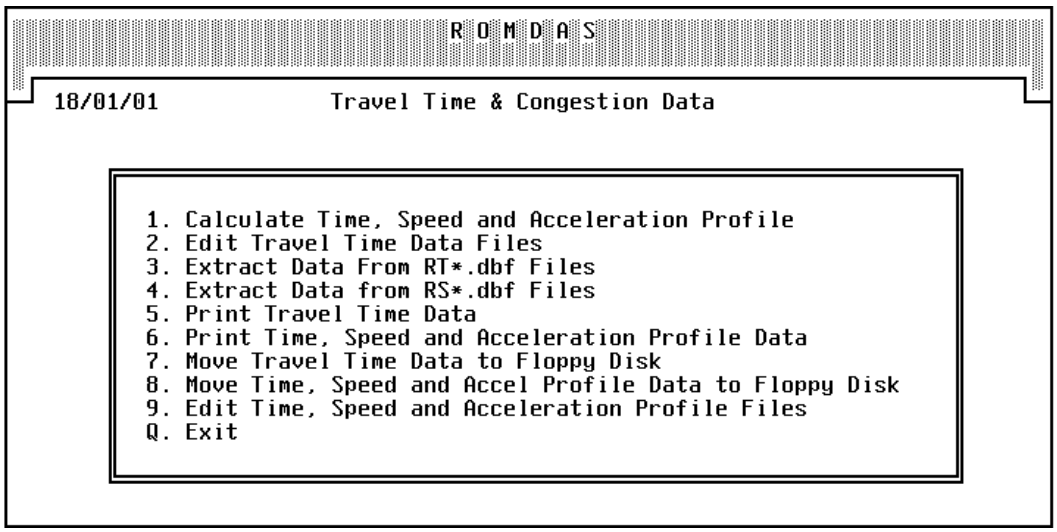

R O M D A S
18/01/01
Travel Time & Congestion Data
1. Calculate Time, Speed and Acceleration Profile
2. Edit Travel Time Data Files
3. Extract Data From RT*.dbf Files
4. Extract Data from RS*.dbf Files
5. Print Travel Time Data
6. Print Time, Speed and Acceleration Profile Data
7. Move Travel Time Data to Floppy Disk
8. Move Time, Speed and Accel Profile Data to Floppy Disk
9. Edit Time, Speed and Acceleration Profile Files
Q. Exit

Figure 17.6: Travel Time and Congestion Survey Data Management Menu

[1] Sayers, M.W., Gillespie, T.D. and Paterson, W.D.O. (1986). *Guidelines for the Conduct and Calibration of Road Roughness Measurements.* World Bank Technical Paper No. 46, The World Bank, Washington, D.C.

© 2001 Data Collection Ltd.

Box 17.2 Accuracy of Surveys

It must be appreciated that the accuracy of the survey is dependent upon the number of pulses from the vehicle odometer to ROMDAS. If, for example, the calibration factor is 1000 this indicates that there are 1000 pulses/km or 1 pulse/m. The accuracy of the measurements will therefore be +- 1 m/s, or +- 3.6 km/h. The higher the resolution of the distance measurement the better the accuracy of the surveys. DCL supply a high resolution distance measurement instrument for applications where high accuracy is required and the vehicle odometer is not sufficiently accurate.

17.5 KEYBOARD RATING DATA

The Keyboard Rating Data menu results in the menu illustrated in Figure 17.7. The options are similar to those with the roughness data files described above in Section 17.3 and a full description is given there. The only major difference lies in the "Extract Keyboard Rating Data" option and this is described below.

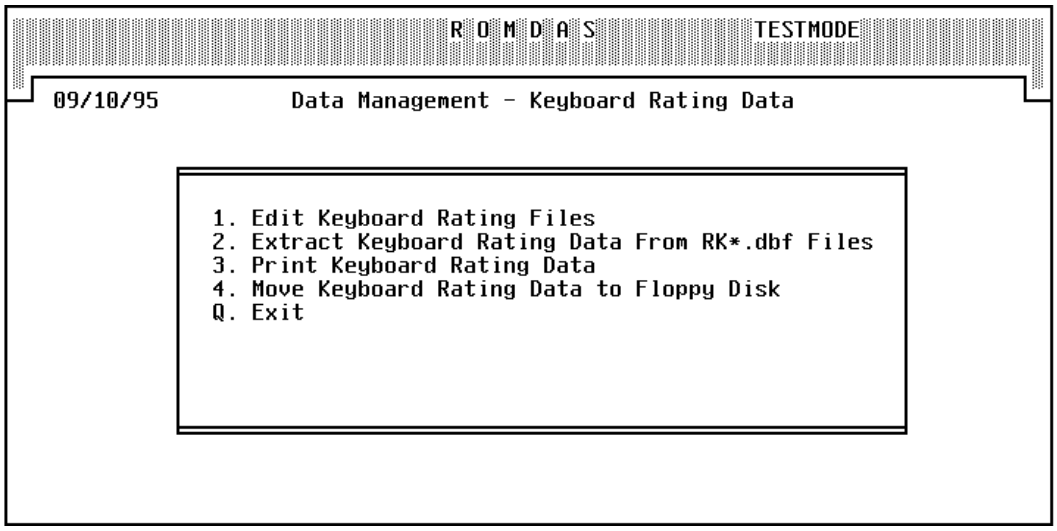

R O M D A S
TESTMODE
09/10/95
Data Management - Keyboard Rating Data
1. Edit Keyboard Rating Files
2. Extract Keyboard Rating Data From RK*.dbf Files
3. Print Keyboard Rating Data
4. Move Keyboard Rating Data to Floppy Disk
Q. Exit

Figure 17.7: Keyboard Rating Data Menu

Extract Keyboard Rating Data

This option prepares output files which contain the keyboard event data. These files consist of the key, the chainage where it was pressed, and the user supplied definition of each key. The first 5 records are the header information. There is then one record for each event. The fields in this file are:

Column 1	The type of record (RECTYPE)
Column 2	The event description
Column 3	The key which was pressed
Column 4	The start chainage of the event
Column 5	The start LRP of the event
Column 6	The end chainage of the event
Column 7	The end LRP of the event

© 2001 Data Collection Ltd.

When it is a point event there is only one entry so the end chainage is 0. When it is a continuous event, there is a start and end.

As with the roughness data, these are extracted to fixed or variable length files.

17.6 LOCATION REFERENCE POINT DATA

The LRP data management menu is illustrated in Figure 17.8. The options are similar to those with the roughness data files described above in Section 17.3 and a full description is given there.

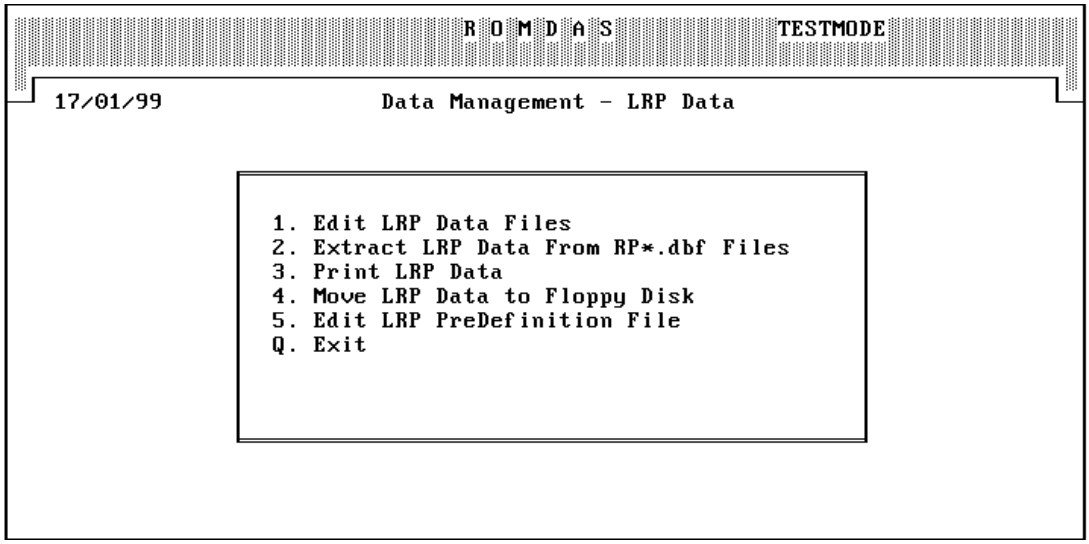

R O M D A S
TESTMODE
17/01/99
Data Management - LRP Data
1. Edit LRP Data Files
2. Extract LRP Data From RP*.dbf Files
3. Print LRP Data
4. Move LRP Data to Floppy Disk
5. Edit LRP PreDefinition File
Q. Exit

Figure 17.8: LRP Data Management Menu

When the LRP data are extracted to a file there are 5 lines of headers followed by the data. These data are:

Column 1	The type of record (RECTYPE)
Column 2	The LRP number
Column 3	The LRP chainage in m
Column 4	The LRP description

17.7 TRANSVERSE PROFILE LOGGER DATA

Figure 17.9 illustrates the transverse profile logger (TPL) data management menu.

The first item converts and standardises the raw data to the elevation in mm. The steps involved in this calculation are described in Section 11.3. It is stored in a file named RWxxxxxx.DBF, where xxxxxx is the name of the roughness survey file. The process will integrate the gyro data from the RXxxxxxx file based on the survey time as well as calculating the crossfall in degrees.

The remaining menu items are the same as in the other data management menus.

© 2001 Data Collection Ltd.

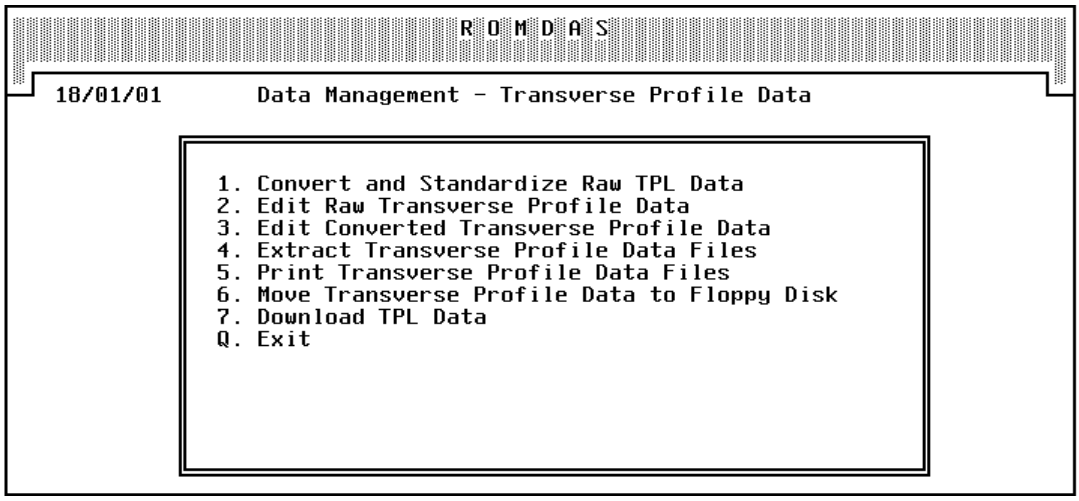

R O M D A S
18/01/01
Data Management - Transverse Profile Data
1. Convert and Standardize Raw TPL Data
2. Edit Raw Transverse Profile Data
3. Edit Converted Transverse Profile Data
4. Extract Transverse Profile Data Files
5. Print Transverse Profile Data Files
6. Move Transverse Profile Data to Floppy Disk
7. Download TPL Data
Q. Exit

Figure 17.9: Transverse Profile Data Management Menu

17.8 GPS DATA

Figure 17.10 shows the GPS data processing options. Many options are similar to those for other surveys, but the ones which differ are described below.

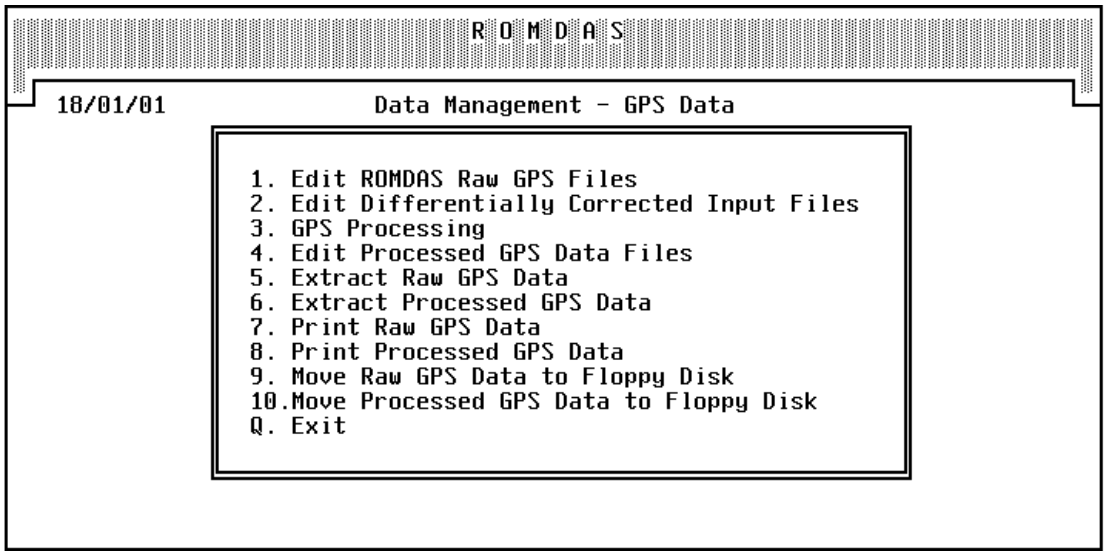

R O M D A S
18/01/01
Data Management - GPS Data
1. Edit ROMDAS Raw GPS Files
2. Edit Differentially Corrected Input Files
3. GPS Processing
4. Edit Processed GPS Data Files
5. Extract Raw GPS Data
6. Extract Processed GPS Data
7. Print Raw GPS Data
8. Print Processed GPS Data
9. Move Raw GPS Data to Floppy Disk
10.Move Processed GPS Data to Floppy Disk
Q. Exit

Figure 17.10: GPS Data Management Menu

Edit ROMDAS Raw GPS File

This allows you to edit the contents of the ROMDAS GPS file (RG******.DBF).

© 2001 Data Collection Ltd.

Edit Differentially Corrected Input Files

As described in Chapter 13, post-processed differentially corrected data can be used to replace the ROMDAS GPS data with much more accurate data. This option allows you to edit the differentially corrected data files (DC******.DBF).

Process GPS Data

This option processes the GPS data, applying the options specified in Section 5.6.11.

Edit Processed GPS Data

This option edits the data which have been processed.

17.9 GRIPTESTER DATA

This menu provides access to editing GripTester skid resistance data.

17.10 TRAFFIC COUNT DATA

This menu is used to process the moving traffic survey data. It consists of the standard menus for editing files, as well as an option to calculate the AADT using the methods described in Chapter 15.

17.11 MISCELLANEOUS DATA

Figure 17.11 shows the menus available when selecting this option. These menus are described below.

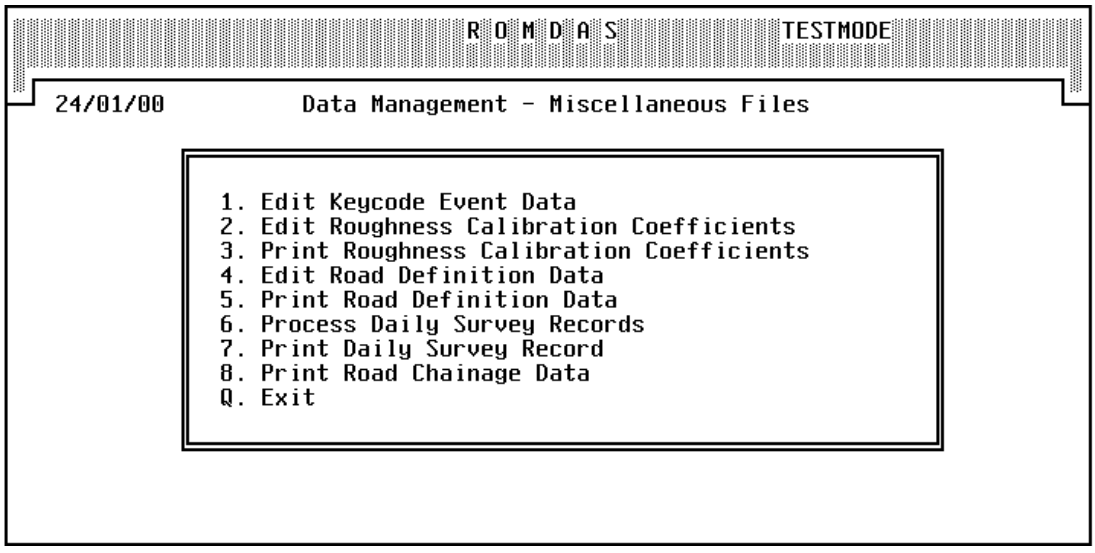

R O M D A S
TESTMODE
24/01/00
Data Management - Miscellaneous Files
1. Edit Keycode Event Data
2. Edit Roughness Calibration Coefficients
3. Print Roughness Calibration Coefficients
4. Edit Road Definition Data
5. Print Road Definition Data
6. Process Daily Survey Records
7. Print Daily Survey Record
8. Print Road Chainage Data
Q. Exit

Figure 17.11: Miscellaneous Data Management Menu

© 2001 Data Collection Ltd.

17.11.1 Edit Keycode Event Data

This option provides access to editing the keycode event file. This was described in Section 5.3.1.

17.11.2 Edit Roughness Calibration Coefficients

This option permits the editing of the roughness calibration coefficients. This was described earlier in Section 5.3.2.

17.11.3 Print Roughness Calibration Coefficients

This option prints the files of roughness calibration coefficients.

17.11.4 Edit Road Definition Data

The Road Definition data file contains survey information pertaining to each Road ID. When the user types the Road ID on the survey opening screen these data are inserted into the appropriate fields. The contents of the file are illustrated in ANNEX M.

17.11.5 Print Road Definition Data

This option will print the Road Definition data file (ROADDAT.DBF).

17.11.6 Process Daily Survey Record

The daily survey record stored in the file RDxxxxxx.DBF is a record of the survey events. It records the LRP, chainage, cumulative chainage and cumulative time whenever there was an event such as the end of a sampling interval (*i.e.* every 100 m in a roughness survey) or an LRP or a keycode event. These data are useful for reconciling the survey data against other information, for example a video, and also as a check.

This menu item gives three options:

- **Create Master Survey Log** - combines the daily survey logs from individual surveys into a single 'master' file. This is useful for confirming that all roads have been surveyed.
- **Check Master Survey Log** - checks the Master Survey Log file for duplicate surveys.
- **Print List of Duplicate Records** – prints the list of duplicate records.
- **Edit Master Survey Log** - Allows you to edit the Master Survey Log file.

17.11.7 Print Daily Survey Log

This option allows you to print the daily survey logs.

17.11.8 Print Road Chainage Data

This option prints the Road Chainage data files (RDxxxxxx.DBF).

© 2001 Data Collection Ltd.

17.12 EXTRACT TO CUSTOM SYSTEMS

This option will prepare output files which can be directly imported into any users database. ROMDAS is currently designed to extract files for use in the dROAD database marketed by Deighton & Associates of Canada. ROMDAS can be easily customised for other user's databases. Please contact the DCL for details.

17.13 DELETE FILES

Selecting this option presents a menu of the different types of data collected with ROMDAS for deleting.

© 2001 Data Collection Ltd.

18. ROMDAS ROAD MANAGEMENT SYSTEM

18.1 Introduction

The ROMDAS Road Management System (RMS) is an application which provides an integrated environment for displaying ROMDAS data. The RMS will integrate data from the different ROMDAS instruments–such as roughness, transverse profile and keycode events–into a single Microsoft Access ® database. The data in this database can be displayed in a graphical format as the user 'drives' down the road. If video images have been recorded with up to three cameras and digitised as .AVI files, these can be played back at the same time. A routine is included which will calibrate the digitised frames to observed chainages on the road. The RMS can also be used to manipulate LRP files, such as reversing their direction or creating LRP files from existing databases.

A full description of the RMS is given in the RMS User's Guide or its online help.

Box 18.1 Trying the RMS

The RMS is included with the ROMDAS CD. It is a fully functional version with the only limitation that the number of records that can be integrated or played is restricted to 100. Upon purchase of the software a password is given which makes it fully operational.

18.2 Using the RMS

The ROMDAS Road Management System (RMS) is designed to display and review data collected in ROMDAS surveys. It integrates the video, roughness, transverse profile and keycode data into a single framework. The user can then 'drive' down the road. To use the system, there are one or two preparatory steps required, depending on whether or not you have a video:

- **Creating an Integrated File.** This takes the ROMDAS Data Collection survey files–for example roughness, keycode and transverse profile–and integrates them into a single Microsoft Access ® database.
- **Calibrate Video Images.** If the ROMDAS Video System has been used to record one or more images of the road (Front/Left Side/Right Side) and the images have been digitised to the computer, the images must be calibrated before they can be reviewed. This sees the individual frames in the video associated with survey chainages. The frame numbers at different survey chainages are used to update the integrated data file.

Once the integrated file is completed you can then use the RMS to display the survey results. This consists of a series of windows with the data plotted as well as a video window. You then can 'drive' down the road to review the data.

The ROMDAS RMS Workspace is the basic work area for the entire program. It contains a toolbar at the top with a number of control icons. When first started the workspace is empty and the only buttons that can be selected are:

- **Open File**. This opens an existing integrated database.
- **Integrate Data**. This allows you to integrate the ROMDAS survey data into a file for playing in the RMS.

© 2001 Data Collection Ltd.

- **Calibrate Video**. This allows you to calibrate the video images to correlate the digitised video frame to a location on the road.

Once the integrated file has been created you can perform additional functions during the playback.

18.3 Integrating data

The MS-DOS version of ROMDAS stores its data in the following individual files based on the type of data collected:

- Master Survey Log (RD******.dbf)
- Roughness - Raw (RR******.dbf)
- Roughness - Processed (RC******.dbf)
- Keycode (RK******.dbf)
- Location Reference Point (RP******.dbf)
- GPS (RG******.dbf)
- Transverse Profile - Raw (RV******.dbf)
- Transverse Profile - Processed (RW******.dbf)

The purpose of the RMS data integration routine is to combine all these individual files into a single file with common chainage. It is then possible to establish the complete picture for what is happening for any section of road by simply locating the appropriate chainage.

The integration uses the following files:

- Master Survey Log
- Roughness - Processed
- Keycode
- Location Reference Point
- Transverse Profile - Processed

As shown in the screen shot in Figure 18.1, the user selects the master run file and from this the other survey files are established. The user can also define their own files which, as long as they are referenced correctly, will be integrated into the system.

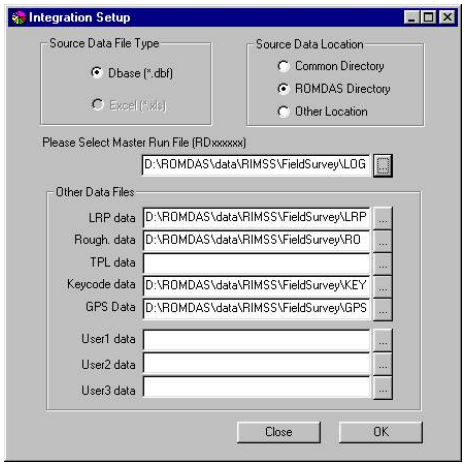


Figure 18.1: Data Integration Input Files

The raw data files are not used since they need to be processed in order to have any meaningful data.

© 2001 Data Collection Ltd.

The GPS data are stored and displayed in numerical format in the RMS. In later releases they will be used for the graphical display and accessing of data.

The data integration is done using the shortest sampling interval from the roughness or transverse profile files. This is the smallest common denominator for all the surveys.

It combines all the data on the basis of continually increasing chainage to create the file.

18.4 Calibrating the Video

The video calibration routine is used to associate a chainage along the road with a frame on the video.

During surveys the operators start the videos before they start driving down the road. They also end the videos after the have completed the survey. In between, the speed of the vehicle will vary and there may be occassional stops or other interruptions to the survey. This means that once digitised to the computer, it is impossible to establish the exact frame number for a survey location without some form of calibration.

Calibration is done by viewing the video in the RMS software and typing in the chainage displayed on the screen at a series of points along the survey. The accuracy of the calibration is proportional to the number of calibration points so it is recommended that it be done every 100 - 200 m.

The RMS video calibration routine is designed to make this process as simple as possible. The user enters the cumulative chainage on the video overlay and presses enter. The software then records the frame number corresponding to this chainage. These values become the start values for the next section and the process continues until the end of the road is reached. The user can manually halt the video or specify that it should be advanced by a set number of frames and automatically pause.

Figure 18.2 is an example of the display during video calibration.

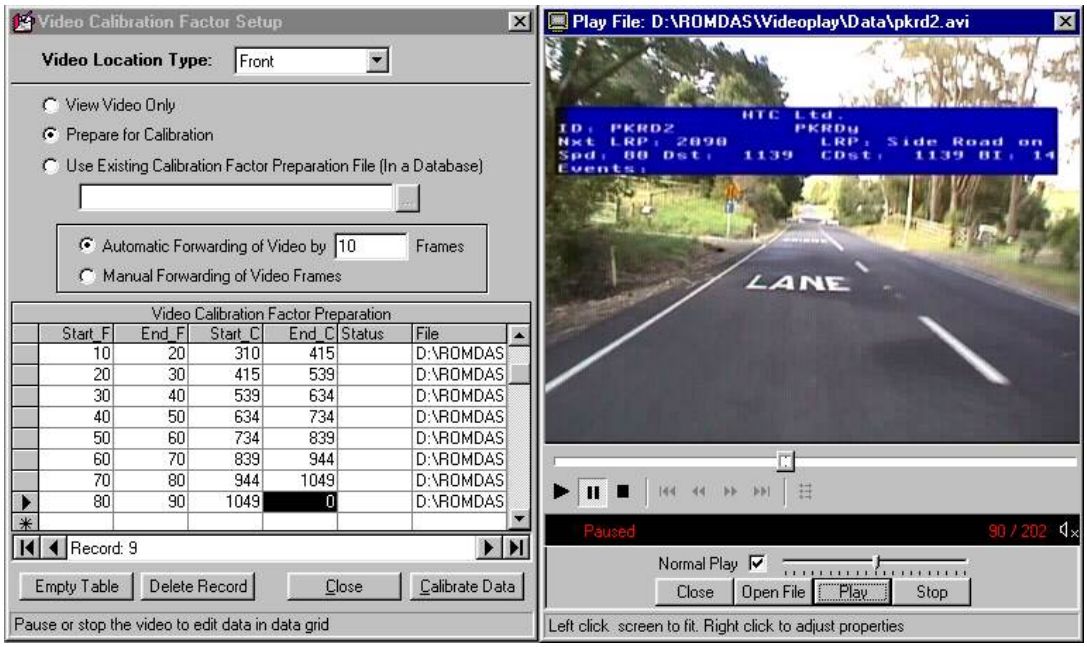


Figure 18.2: Example of Video Calibration Screen

© 2001 Data Collection Ltd.

The data entered are used to develop a linear equation of the form:

FRAME = a x CHAINAGE + b

where FRAME is the video frame number
CHAINAGE is the survey chainage from the start point
a and b are regression coefficients

The values for the coefficients a and b are stored in a table in the integrated data file so they can be used both by the RMS and other applications.

When the user wants to see the video frame for a given chainage the regression equation predicts the frame number and the video is advanced to that location.

During the final stages of the data integration the equations are used to generate a frame number for each location in the RMS integrated file.

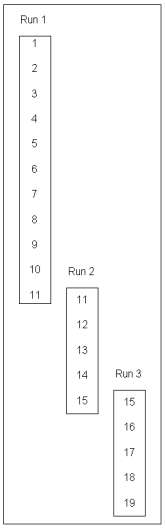
18.5 Survey Management

The RMS contains a number of routines designed to assist with managing surveys. These include:

- Combining databases
- Creating LRP files from other databases
- Reversing LRP directions
- Creating a survey route
- Evaluating chainage data

18.5.1 Combine Databases

Often it is necessary to interrupt the survey along a road. This may be due to factors such as traffic, surveying side roads to improve efficiency, or because of technical issues. However, after the survey the data should be combined to facilitate viewing and sectioning of the data. This is done using the **UTILITIES|COMBINE DATABASES** option.



The problem—and the process for combining databases—is illustrated in the figure to the right. A survey was conducted which went from LRP 1 to just past LRP 10. A second survey was LRP 10 to just past LRP 15; a third LRP 15 to LRP 19. For the combining to work there **must** be an overlap of the data. This means that one survey must start before a previous survey ends.

The first step is to select the files to integrate. These are selected individually from the integrated databases. Selecting **Combine** will create the new file. You will be prompted for the name of the file to save to. The data will then be combined into the new continuous file with increasing LRP and chainage.

18.5.2 Creating LRP Files from Other Databases

LRP data are often held in different databases or other external files, for example a PMS. This feature will import these data and create LRP files for each road link in the file. These LRP files can then be used with the data collection software to improve the accuracy and efficiency of surveys. It is possible to import either Excel .XLS, Access .MDB, dBASE or Text files.

© 2001 Data Collection Ltd.

These files are created with the necessary data, specifically:

- **LINK** The ROAD ID
- **ROADNAME** The Road Name
- **CHAINSTART** The start chainage in km
- **DESCRIPTIO** Description of the start chainage
- **CHAINEND** The end chainage in km
- **DESCRIPTIO1** Description of the end chainage

The data are processed to create .DBF files in the required format which can be used in the ROMDAS surveys.

At the same time that the LRP file is created, the LRP ROADID data and other information is stored in the ROMDAS Road Definition file which is used when executing a survey to define the file names and LRP reset options. When the user types in the ROADID these file names are supplied along with the appropriate settings.

18.5.3 Reversing LRP Directions

Reversing LRP file directions is done when an LRP file has been created in the direction A to B, but for survey reasons the road is to be surveyed from B to A. The RMS analyses the chainages and creates a new file which is appropriate for driving in the opposite direction. Figure 18.3 is an example of original and reversed data.

RECTYPE	LRP_NUMBER	LRP_DISPL	LRP_DESC
			ORIGINAL FILE
1		0	3601
2		0	TUKUAHO ROAD
3		0	12/04/00
4		0	Generated from User Supplied File
5		0	6.568
12	1	0	Malapo - Int. Tukuaho Road
12	2	517	Speed sign left
12	3	1191	Int. Sitili Quarry Road right (3261)
12	4	1876	Pelehake - Int. Vete Quarry Road right (3631)
12	5	2802	Start of LDS fence left - Pelehake
12	6	3311	Speed sign left - End of Pelehake village
12	7	3673	Pelehake - Int. Taupi Road
			REVERSED FILE
1		0	3601
2		0	TUKUAHO ROAD
3		0	12/04/00
4		0	Generated from User Supplied File - Reversed Direction
5		0	6.568
12	1	0	Pelehake - Int. Taupi Road
12	2	362	Speed sign left - End of Pelehake village
12	3	871	Start of LDS fence left - Pelehake
12	4	1797	Pelehake - Int. Vete Quarry Road right (3631)
12	5	2482	Int. Sitili Quarry Road right (3261)
12	6	3156	Speed sign left
12	7	3673	Malapo - Int. Tukuaho Road

Figure 18.3: RMS Roughness Bar and Line Graph Displays

18.5.4 Creating a Survey Route

A survey route consists of a series of LRP files which will be driven continuously. For example, there may be files covering 0 - 10 km; 10 - 20 km and 20 - 25 km. It is proposed to drive this continuously as 0 - 25 km so a new LRP file is required which allows this. The RMS combines the original LRP files into the required format, with consistent chainages for prompting the operators.

© 2001 Data Collection Ltd.

18.5.5 LRP Chainage Evaluation

It is often desirable to assess the accuracy of the LRP chainages as compared to the chainages recorded in the field surveys. This is useful for confirming whether or not the vehicle is within calibration or if there have been changes to LRP positions. The evaluation uses the data from the RK files (Keycode) which are stored during the survey. These are compared to the RP file which is the 'standard' LRP file and a report generated which can be viewed or printed.

18.6 Displaying the Data

Once an integrated database has been created and the video calibrated it is possible to display the data. This is done by either using the current database or opening an existing file.

The data display consists of any or all of the following windows which are arranged on the screen:

- **Video**. This windows displays the digitised video images. There can be up to three windows displayed, for front/left/right side images.
- **TPL**. This window shows a plot of the transverse profile logger data. It can be as a line or a bar graph, going from top to bottom or bottom to top.
- **Condition**. This window is a plot of the roughness, rut depth and keycode rating data. The first two are displayed as line graphs whle the keycode is a bar graph. The location reference points are also overlaid on the screen. You will see the data for sampling intervals in advance and following the current sampling interval.
- **Data**. This window contains the integrated data table.
- **Images**. Images, such as those taken of roadside events with a digital camera.
- **Voice**. Recorded voice data

There are controls for the speed at which the data are displayed as well as for certain display properties.

It is possible to forward to different locations on the road and to halt the display at any point.

The data can be displayed as bar or line graphs, and the user can control the scale of the axes. The charts in Figure 18.4 show the difference with roughness data.

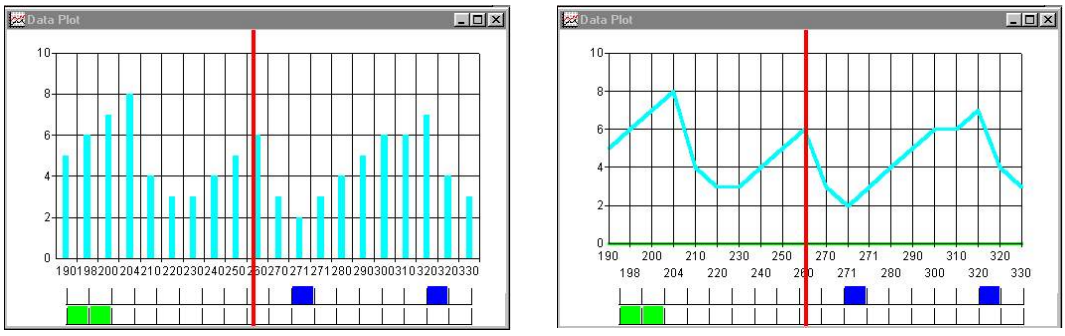


Figure 18.4: RMS Roughness Bar and Line Graph Displays

The blue and green boxes beneath the charts represents keycode events. There is a floating legend toolbar which shows the events approaching.

The red line represents the current position, the data to the left of the line are sections already displayed; to the right data which is coming up.

© 2001 Data Collection Ltd.

The screen shot in Figure 18.5 shows the full display, clockwise from top left:

- Video
- Roughness and keycode events (2 wheelpaths and average)
- Keycode event legend showing upcoming events and their GPS co-ordinates
- Rut bar measurements as vertical bar from top down
- Voice recording .WAV file associated with current location
- Digital photograph of location of roadside culvert
- Table showing all raw data

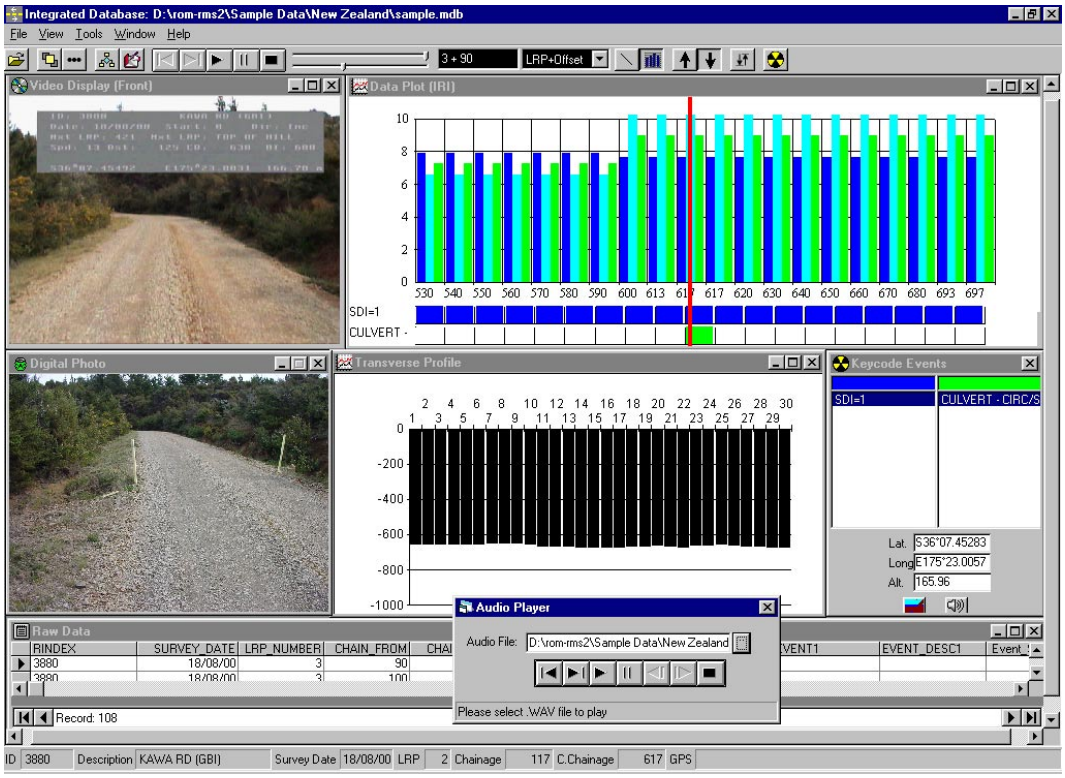


Figure 18.5: Example of Full RMS Display

18.7 Future Developments

It is planned that future modules these will include:

- **GIS Interface**. A map can be scanned and used to associate specific files with locations on the map. It will be possible to click on the map and have the data for that section of the road open and be played.
- **Road Width Estimation**. The width of the road can be estimated from the video by marking two points on the screen.

© 2001 Data Collection Ltd.

19. FUTURE DEVELOPMENTS AND CUSTOMISATION

ROMDAS is a developing product and this can only be achieved through feedback from the users. Please also contact us at DCL with your suggestions for improvements to the system or features that you think should be modified or added (e-mail: info@romdas.com; fax: +64-9-411-9096). Recently released systems include:

- **Laser Surveyor**. Using a laser distance instrument for precisely locating LRPs and roadside events.
- **Digital Cameras**. Recording digital camera data during LRP surveys.
- **Voice Recording**. Integrating data from tape recorders operated during the surveys.
- **Multiple GPS**. Recording data from multiple GPS receivers or gyroscopes to improve positioning.

For the latest details visit our web site at:

http://www.romdas.com

ROMDAS can be easily customised to output data in a format completely compatible with most highway information systems. This will simplify the data processing and importing ROMDAS results to your road or pavement management system. The customisation is done by creating a new output entry option, as described in Section 17.12. Please contact us for details on this service.

In the event that they occur, bug fixes to the software will be supplied *gratis* (i.e. at no charge) to all **registered owners of the current version only**. We regret that we cannot support previous versions of the software. Please ensure that you have registered the system using the form in ANNEX A.

As enhancements become available you will be notified of their release and the cost of an upgrade. As a general policy upgrades are provided without charge for the first 12 months after purchasing ROMDAS. Please note that if you do not upgrade you will no longer be eligible for the *gratis* bug fixes.

© 2001 Data Collection Ltd.

20. LICENCE AND WARRANTY

If the terms of this licence and warranty are unacceptable please return the unused ROMDAS system with 15 days of purchase for a refund, less shipping costs.

Please read this Licence Agreement before using this software. By using this software, you are agreeing to be bound by the terms of this Licence. If you do not agree to these terms, promptly cease all further installation or use of the software. It is agreed that certain restrictions under this Licence only apply to the ROMDAS Road Management System software or, as the case may be, to ROMDAS Data Collection Software.

DEFINITIONS

In this Agreement, "DCL" means Data Collection Ltd.; "DCS" means the ROMDAS Data Collection Software; "LICENSEE" means you, the licensee of the software; "SOFTWARE" means the ROMDAS DCS.

HARDWARE WARRANTY

DCL cannot guarantee that installation of the hardware will be in accordance with the recommended instructions. The hardware has been tested and is considered by DCL to be in operating condition. In the event that it ceases to operate within 60 days of supply, the equipment will be repaired or replaced. DCL expressly exclude damages due to improper installation. For equipment provided by DCL but from other manufacturers—for example inverters—you will need to return the faulty equipment directly to the manufacturer.

SOFTWARE LICENSE

In consideration of your undertaking to comply with the terms and conditions of this Licence Agreement, DCL grants you, LICENSEE, a non-exclusive licence to use the Software and to view the documentation. It is also agreed that the Licence is non-transferable. This Agreement does not grant LICENSEE any rights to patents, copyrights, trade secrets, trade names, trade marks (whether registered or unregistered), or any other rights, functions or licences in respect of the Software.

DCL warrant the software to be free of defects in workmanship and to perform as described in this documentation for a period of 60 days from the date of purchase. In the event of notification within the warranty period, DCL will correct the errors and replace the software at no charge to the end user.

COPYRIGHT AND RESTRICTIONS ON USE

The Software contains copyrighted material and, in its human readable form, it contains trade secrets and proprietary information owned by or licenced to DCL. Title to and ownership of the Software and the documentation that accompanies the Software and all intellectual property rights in the Software and said documentation are and shall remain the sole property of DCL and/or its licensors.

LICENSEE may not de-compile, reverse engineer, disassemble or otherwise reduce it to human readable form. LICENSEE may not modify, rent, lease, loan the Software or distribute copies of it. LICENSEE may not create derivative software based upon any trade secret or proprietary information of DCL and/or its licensors. LICENSEE may not sub-licence, assign or transfer this Licence. LICENSEE may not adapt or use any trademark or trade name which is likely to be similar to or confusing with that of DCL or any of its

© 2001 Data Collection Ltd.

licensors or take any other action which impairs or reduces the trademark rights of DCL or of its licensors.

LICENSEE further acknowledges that this Licence is not a sale or an assignment of DCL and/or its licensors' intellectual property rights in the Software and the accompanying documentation and that DCL and its licensors continue to own title to the Software and copyright to the printed information.

SPECIAL LIMITATIONS FOR NEW ZEALAND AND AUSTRALIA

The use of the ROMDAS DCS software is restricted in New Zealand and Australia. It may not be used for any projects in New Zealand or Australia without the express written permission of Data Collection Ltd. Systems in use in New Zealand and Australia at 1 January 2000 are excluded from this restriction.

NO WARRANTY

DCL does not warrant, guarantee or make any representations that the functions contained in the Software will meet LICENSEE's requirements or that the operation of the Software will be uninterrupted or error-free. Any other Software and any hardware furnished with or accompanying the Software is not warranted by DCL.

LIMITATION OF LIABILITY

THE SOFTWARE IS PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED, AND TO ANY REMEDY AGAINST DCL AND/OR ITS LICENSORS, WHETHER IN CONTRACT, TORT, DELICT, QUASI-DELICT OR OTHERWISE. SOME JURISDICTION DO NOT ALLOW THE EXCLUSION OF CERTAIN IMPLIED WARRANTIES SO THE PRECEDING EXCLUSIONS MAY NOT APPLY.

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT WILL DCL AND/OR ITS LICENSORS BE LIABLE FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL OR DIRECT OR INDIRECT DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OF PROFIT) ARISING OUT OF LICENSEE'S USE OR INABILITY TO USE THE SOFTWARE OR PRINTED INFORMATION ACCOMPANYING IT, WHETHER OR NOT DCL AND/OR ANY OF ITS LICENSORS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY. THIS EXCLUSION INCLUDES ANY LIABILITY THAT MAY ARISE OUT OF THIRD-PARTY CLAIMS AGAINST LICENSEE. THESE LIMITATIONS SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY.

TO THE MAXIMUM EXTENT PERMITTED BY LAW, IN NO EVENT SHALL DCL AND/OR ITS LICENSORS BE LIABLE TO THE CONTINUED AVAILABILITY OF SEARCH ENGINES OR CATEGORIES INCLUDED IN THE SOFTWARE OR UTILIZED BY IT. DCL AND/OR ITS LICENSORS MAKES NO WARRANTY WITH RESPECT TO THE ACCURACY, CORRECTNESS, TIMELINESS OR SUITABILITY OF THE CONTENT OF ANY SERVICE OR INFORMATION PROVIDED BY ANY SEARCH ENGINE OR DIRECTORY, AND TAKES NO RESPONSABILITY THEREFORE.

TERMINATION

This Licence shall remain in full force and effect unless and until terminated. This Licence will terminate immediately, automatically and without notice if LICENSEE fails to comply

© 2001 Data Collection Ltd.

with any provision of this Agreement. Upon termination, LICENSEE must stop using the Software, erase or destroy all copies of the Software, and destroy all printed information provided with the Software.

ENTIRE AGREEMENT

This agreement constitutes the entire agreement between you and DCL and supersedes any other prior agreements or communications regarding the Software. If any provision of this agreement is held invalid, the remainder of this agreement shall continue in effect.

WAIVER

The failure by DCL or any of its licensors to enforce at any time any of the provisions of this agreement, to exercise any election or option provided herein, or to require at any time the performance by you of any of the provisions herein will not in any way be construed as a waiver of such provisions.

LANGUAGE OF AGREEMENT

LICENSEE agrees that this agreement be drafted in the English language.

GOVERNING LAW

This Agreement shall be governed and be construed in accordance with the laws of New Zealand.

Copyright (c) Data Collection Ltd. 1999-2001

LIST OF ANNEXES

A	ROMDAS User Registration Form
B	Parts List
C	Schematic Diagrams Showing ROMDAS Connections
D	Pin Assignments for ROMDAS Connectors
E	Distance/Speed Sensor Manufacturer's Installation Instructions
F	Installation of Roughness Meter
G	Transverse Profile Logger
H	Installing the ROMDAS Video System
I	Fabricating a Proximity Sensor
J	Calibrating a Road Roughness Meter to IRI
K	Travel Time and Congestion Surveys
L	Importing Data to Custom Databases
M	ROMDAS File Structures
N	Step-by-step Instructions
O	Problem Solving with ROMDAS
P	Computer Compatibility Issues
Q	ROMDAS Circuit Diagram
R	Connecting Peripheral Devices
S	Preparing a Boot Menu
T	Programing the Rating Keyboard
U	Creating a Shortcut to ROMDAS Under Windows

© 2001 Data Collection Ltd.

ANNEX A ROMDAS USER REGISTRATION FORM

Contact Name: _____

Organisation: _____

Mailing Address: _____

_____

_____

_____

Telephone: _____ FAX: _____

E-mail: _____

ROMDAS Serial Number (VERY IMPORTANT!) _____

Make/Model of Computer _____

Version of MS-DOS _____ Processor 386 486 Pentium Other

Date of Purchase _____

Please Return This Form To:

ROMDAS Registration
Data Collection Ltd.
P.O. Box 348
Motueka, 7161
NEW ZEALAND
Fax (NZ): +64-3-528-8213
E-mail: info@romdas.com

© 2001 Data Collection Ltd.

ANNEX B PARTS LIST

Refer also to Chapter 3 on ROMDAS Installation

IMPORTANT

The correct installation and connection of ROMDAS and its accessories is essential for the proper and long-term reliability of the system.

We **strongly recommend** that the power supply/wiring harness, distance/speed sensor and the reverse option (if required) be installed by a qualified automobile electrician/mechanic.

B.1 STANDARD ITEMS - ROMDAS HARDWARE INTERFACE

3.5" disk with ROMDAS software

1 x CD with ROMDAS manual and additional programs. Note that this CD may not work on all CD players due to its format. All material is available on the web site www.ROMDAS.com

1 x ROMDAS Hardware Interface

1 x Distance/Speed Sensor (see ANNEX D)

1 x Extension Cable for Distance/Speed Sensor to ROMDAS

1 x Power Switch

1 x Tester

1 x 9 Pin DIN male to 9 pin DIN female RS-232 straight through cable

1 x Multimeter

2 x Spare fuses for power switch

B.2 STANDARD ITEMS - ROMDAS BUMP INTEGRATOR

1 x ROMDAS Bump Integrator

1 x Installation Kit

1 x Extension Cable for BI to ROMDAS

1 x Spare Spring

B.3 OPTIONAL EXTRAS AND SPARES

To use ROMDAS in more than one vehicle the following items are available:

© 2001 Data Collection Ltd.

A. Distance/Speed Sensor
B. Extension Leads for Odometer and/or BI to ROMDAS
C. Protective Box for ROMDAS
D. Wiring Harness (v 2 Hardware Interface only)

See the ROMDAS catalogue for a list of all spares.

B.4 EMERGENCY SPARES

It is recommended that the following spares be available at all times:

A. BUMP INTEGRATOR

(a) Spare Bump Integrator Wire
(b) Spare Optical Sensor (if using Farnell BI) (Radio Spares 304-560)

B. ROMDAS Hardware Interface

(a) Spare Distance/Speed Sensor
(b) Spare 1.0 Amp Fuses

© 2001 Data Collection Ltd.

ANNEX C SCHEMATIC DIAGRAMS OF ROMDAS CONNECTIONS

Figures C.1 to C.3 are schematic diagrams of the ROMDAS connections.

© 2001 Data Collection Ltd.

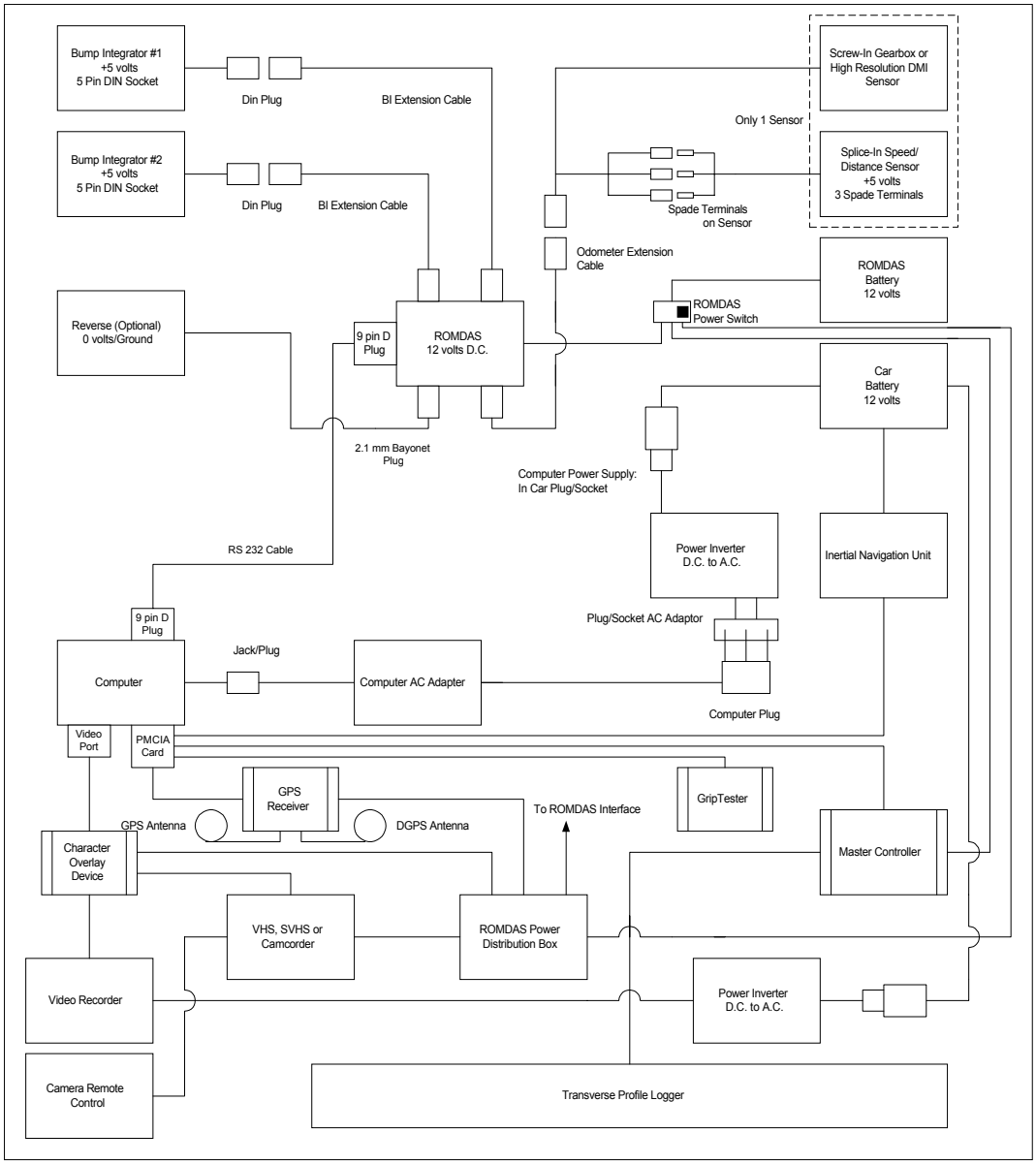


Figure C.1: ROMDAS Schematic Diagram - Version 5 Hardware Interfaces

© 2001 Data Collection Ltd.

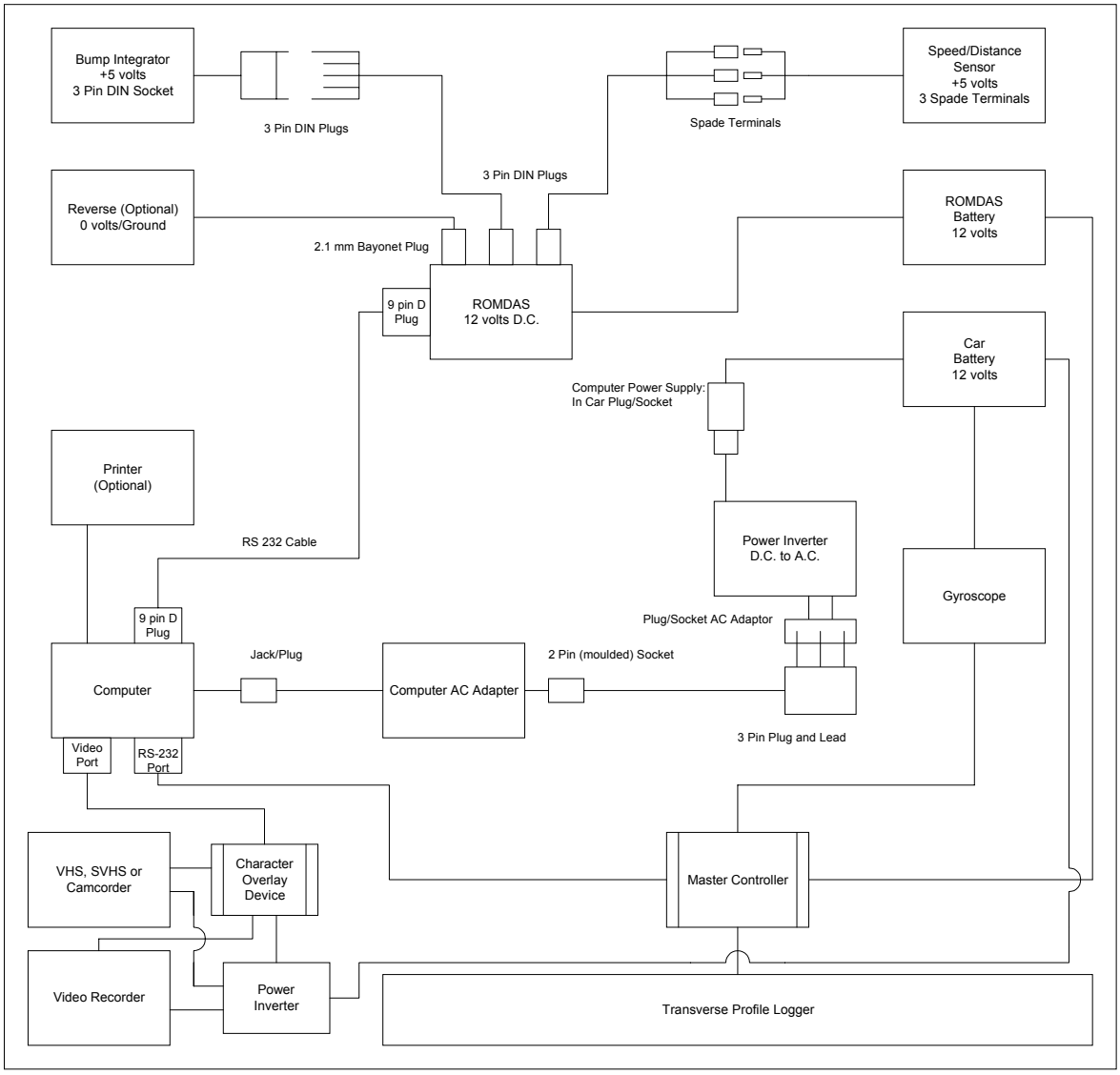


Figure C.2: ROMDAS Schematic Diagram - Version 3 and 4 Hardware Interfaces

© 2001 Data Collection Ltd.

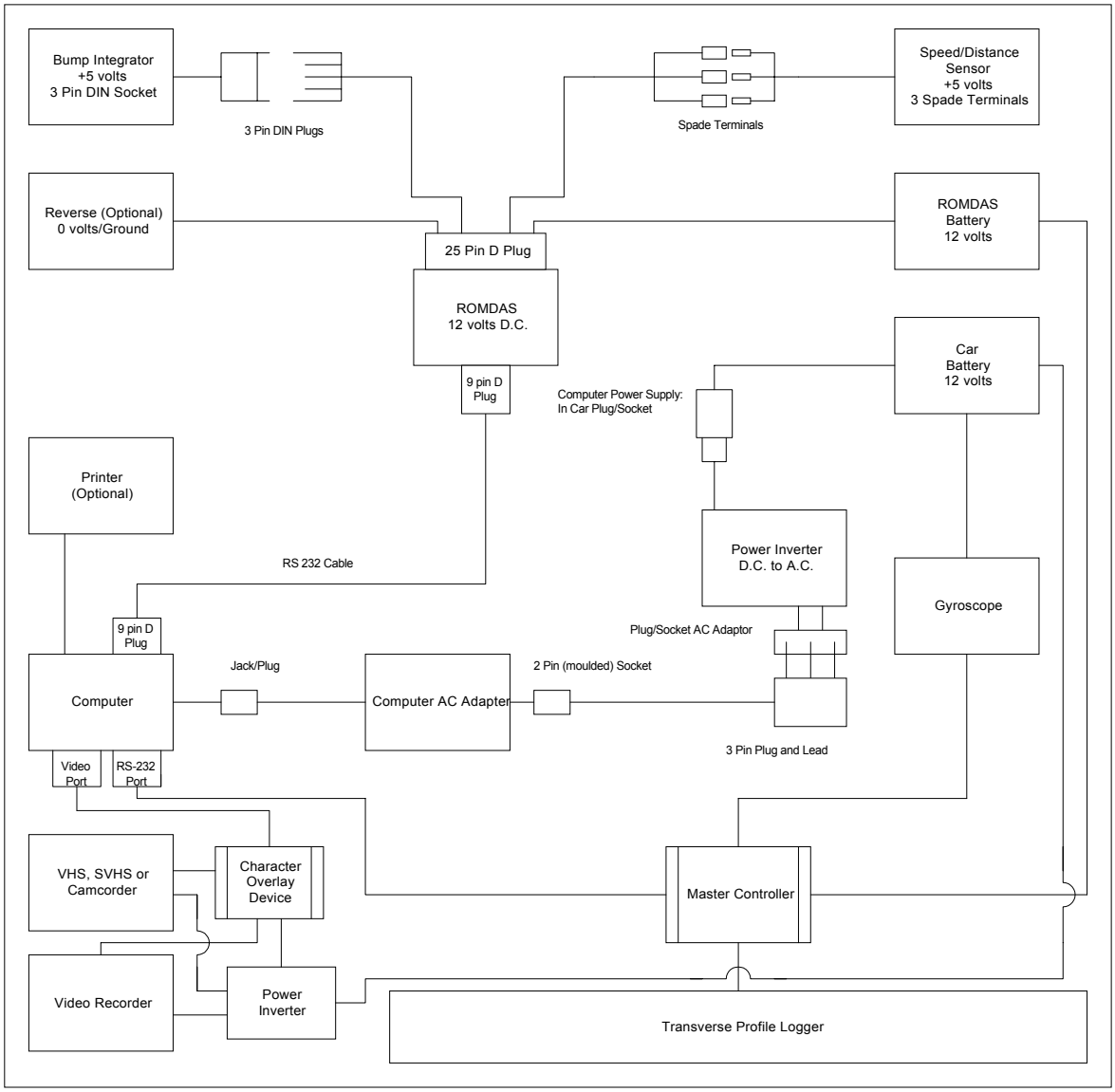


Figure C.3: ROMDAS Schematic Diagram - Version 2 Hardware Interface

© 2001 Data Collection Ltd.

ANNEX D ROMDAS CONNECTORS AND PARTS

VERSION 3 to 5 HARDWARE INTERFACES

The Version 3 and 4 hardware interface uses 2 DIN plugs to connect the odometer and roughness meter; bayonet plugs for the reverse switch and power. With reference to Figure D.1, looking at the ROMDAS socket the pins assignments are:

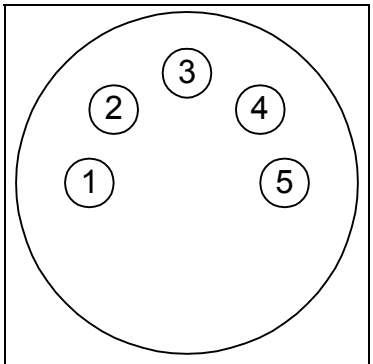


Figure D.1:
DIN Pin Assignment

Standard Odometer

Pin 1 -	Brown	+5 v Power
Pin 3 -	Green	Earth
Pin 5 -	Blue or White	Signal

Stegmann High Resolution DMI Encoder

Pin 1 -	Red	+5 v Power
Pin 3 -	Blue	Earth
Pin 5 -	Black	Signal

Roughness Meter – v 3 Hardware Interface

Pin 1 -	Brown	+5 v Power
Pin 3 -	Green	Earth
Pin 5 -	Blue or White	

NOTE: ROMDAS BI has pin 2 – 5 connected.

Roughness Meter – v 4 Hardware Interface

Pin 1 -	Brown	+5 v Power
Pin 3 -	Green	Earth
Pin 4 -	Red	Signal - BI #2
Pin 5 -	Blue or White	Signal - BI #1

NOTE: With the ROMDAS BI there is a diode connecting pins 3 and 4 for BI #1 and 3 and 5 for BI #2 (see below)

Power - 2.5 mm Plug

Centre Pin	Brown	+12 v Power
Outer Pin	Blue or White	Earth/Negative (-)

Reverse Switch - 2.1 mm Plug

Centre Pin	Brown	+12 v Power
Outer Pin	Blue or White	Earth/Negative (-)

© 2001 Data Collection Ltd.

VERSION 2 HARDWARE INTERFACE

The following are the pin assignments for the v 2 Hardware Interface 25 pin RS-232 plug:

Pin	Connection
3	Reverse light connection
7	Bump Integrator output to ROMDAS
8	+5 volts to speed/distance sensor
	+5 volts to Bump Integrator
11	Earth from vehicle
13	+12 volt supply from vehicle
20	Speed/distance sensor output to ROMDAS
24	Earth to speed/distance sensor
	Earth to Bump Integrator

SERIAL CABLES

The following are the standard wiring colours for the serial cables used with ROMDAS. However, these should be checked to confirm that they have not been altered due to variations between some manufacturers.

Pin	Function	Wire Colours
		Beige Cable
1	Carrier detect (CD)	Black
2	Receive data (RD)	Brown
3	Transmit data (TD)	Red
4	Data terminal ready (DTR)	Orange
5	Signal ground	Yellow
6	Data set ready (DSR)	Green
7	Request to send (RTS)	Blue
8	Clear to send (CTS)	Purple
9	Ring indicator (RI)	White

NULL MODEM

To test if the ROMDAS serial communications are working you can build a null-modem plug. This sees the following pins connected on the RS-232 plug:

TD – RD	Pin 1 – 2
DTR – DSR	Pin 4 – 6
CD-RTS-CTS	Pin 1 – 7 - 8

TRANSVERSE PROFILE LOGGER

The Transverse Profile Logger uses a DB9 plug for its connections. The following are the connections between the Master Controller and the computer:

© 2001 Data Collection Ltd.

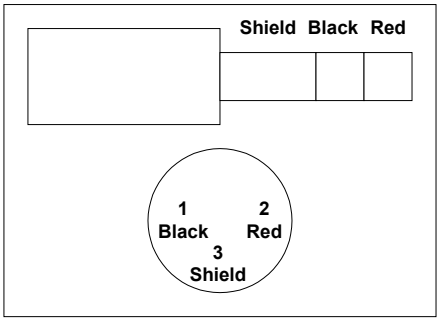
Pin Number		Function
Master Controller	**Computer**	
1	5	Ground
3	2	RS-232 - Master Controller to Computer
5	3	RS-232 - Computer to Master Controller
2	-	Power Supply Ground (-)
8	-	Power Supply Positive (+)

The TPL temperature sensor has four the following wiring connections:

Connection	Pins	Wiring Colours
Power +	1, 2	Black, Brown
RS +	8, 9	Purple, White
RS -	6, 7	Green, Blue
Ground	3, 4	Red, Orange

VIDEO REMOTE

The video remote used with the Sony video system is an accessory normally supplied with the VCT550RM Video Camera Tripod or else can be ordered as a spare part (A-6776-079-A). The remote comes with a 100 mm cable so it is necessary to fabricate an extension cable. The cable has a 2.5 mm stereo socket on one end for the remote to plug into and a 2.5 mm stereo plug on the other end to plug into the LANC socket on the camera. It is a straight through connection so that the shield on the input plug matches the shield on the output, the white to white and the red to red. The following shows the connections for the plug and the back of the 2.5 mm stereo plug for this extension cable.



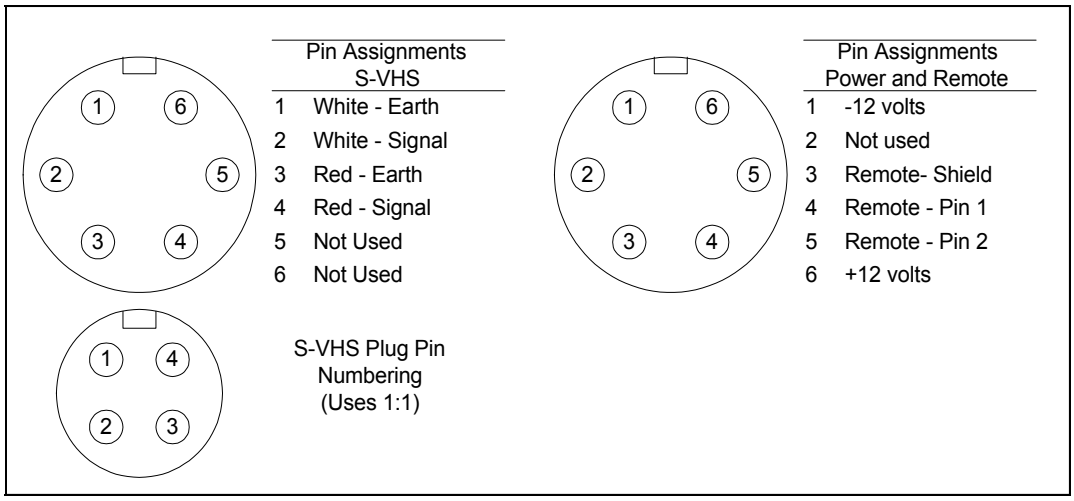
VIDEO SYSTEM

The video system camera is contained in an environmentally protected housing on the outside of the vehicle. The camera is sends its signal to the overlay device via a S-VHS cable. There is also a remote control and power cable.

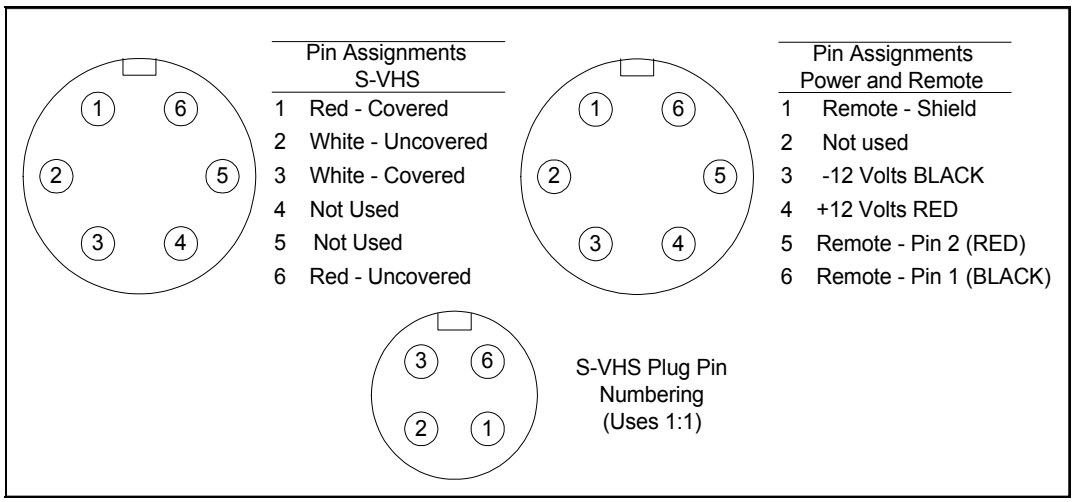
All cables are connected to the housing through sealed connectors. There is a plug for the S-VHS cable and socket for the power/remote cable so that they cannot be accidentally reversed.

The pin assignments used with these cables is as shown below. The figures also show the S-VHS cable numbering which goes into the camera. It will be noted that there is a 1:1 connection.

© 2001 Data Collection Ltd.



Version 1-2 Systems



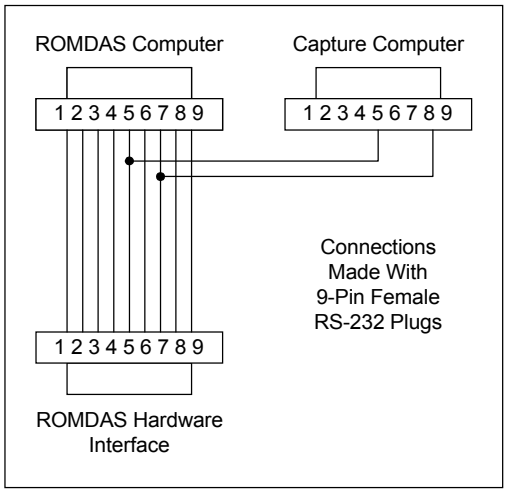
Version 3 Systems

VIDEO CAPTURE TRIGGER

To trigger the ROMDAS video capture control software on the capture computer the following pins must be connected:

ROMDAS Computer RTS – CAPTURE Computer CTS	Pin 7 – 8
ROMDAS Computer GND – CAPTURE Computer GND	Pin 5 – 5

© 2001 Data Collection Ltd.



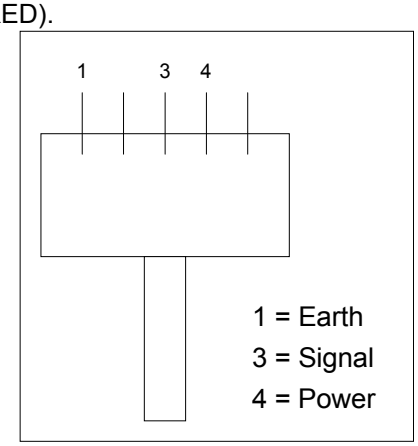
HIGH RESOLUTION DMI

V3 - Stegmann High Resolution DMI Encoder

Pin 1 -	Red	+5 v Power
Pin 3 -	Blue	Earth
Pin 5 -	Black	Signal

V2 - HP High Resolution DMI Encoder

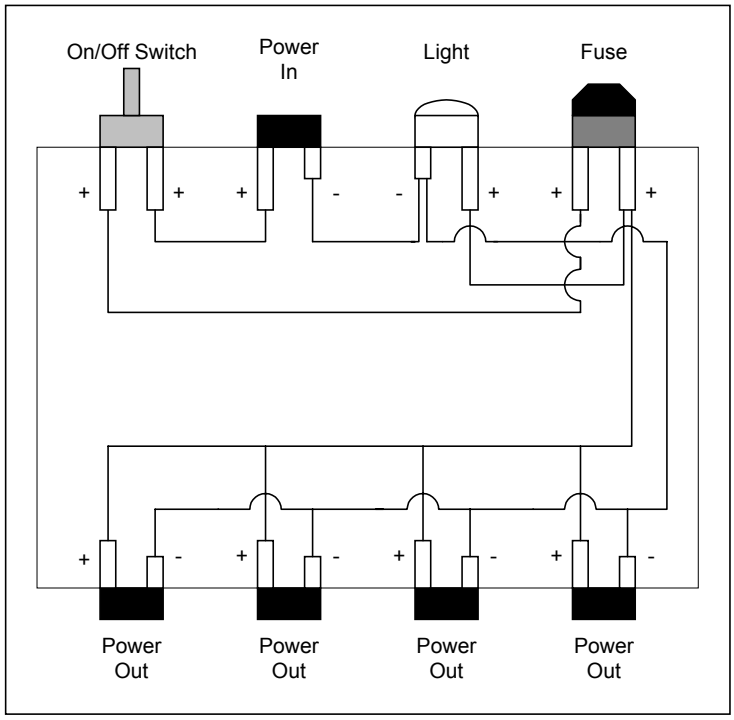
The following are the pin connections for the high resolution DMI from v 2 onwards. (1=BLACK; 3=WHITE; 4=RED).



POWER DISTRIBUTION BOX – v 1

The following shows the connections for the v 1 power distribution box.

© 2001 Data Collection Ltd.

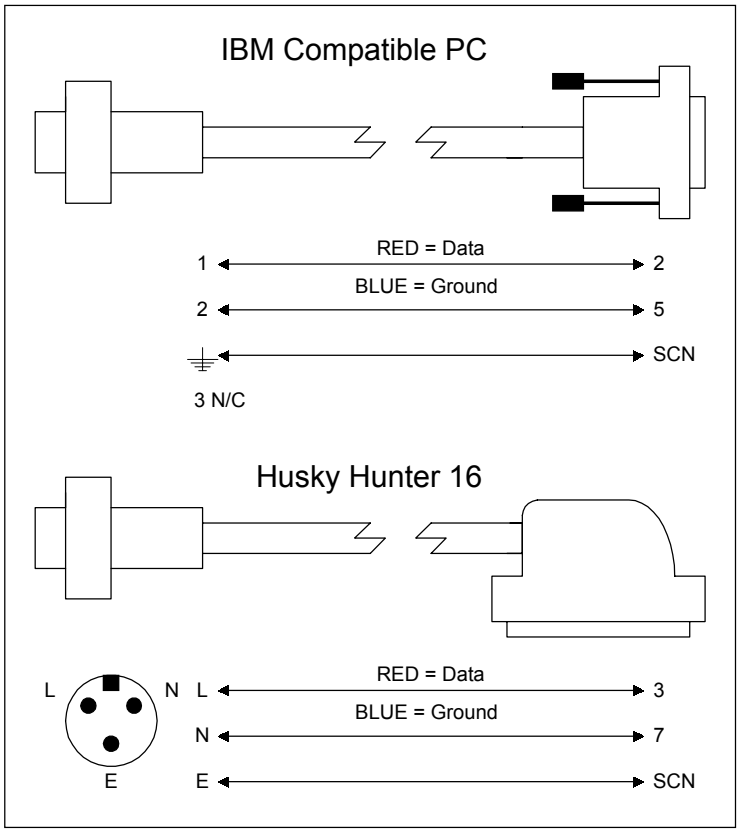


GRIPTESTER

As shown in the following figure, the GripTester has two types of cables: one for an IBM Compatible PC and a second for the Husky Hunter. The pin connections for these cables are described in the GripTester Maintenance Manual. With reference to this manual, the RED line is used for the signal/data; the BLUE is ground.

For use with ROMDAS it is necessary to have an IBM Compatible PC connection with Pin 2 as signal; 5 as ground. Users with the Husky connection will need to modify their cable accordingly or purchase a replacement cable from Findlay Irvine.

© 2001 Data Collection Ltd.



GripTester Pin Assignments (from GripTester manual)

GYROSCOPE

The KVH gyroscope has a 15 pin female socket which is connected to a 2-core cable, male and female RS-232 cables. The connections are given below.

1. Red (2-core cable)
2. Black (2-core cable)
3. Red (female)
4. Not Used
5. Brown (male)
6. Not Used
7. Brown (female)
8. Not Used
9. Red (male)
10. Not Used
11. Black (2-core cable)
12. Not Used
13. Not Used
14. Not Used

1. Red
2+11. Black

2-Core Cable

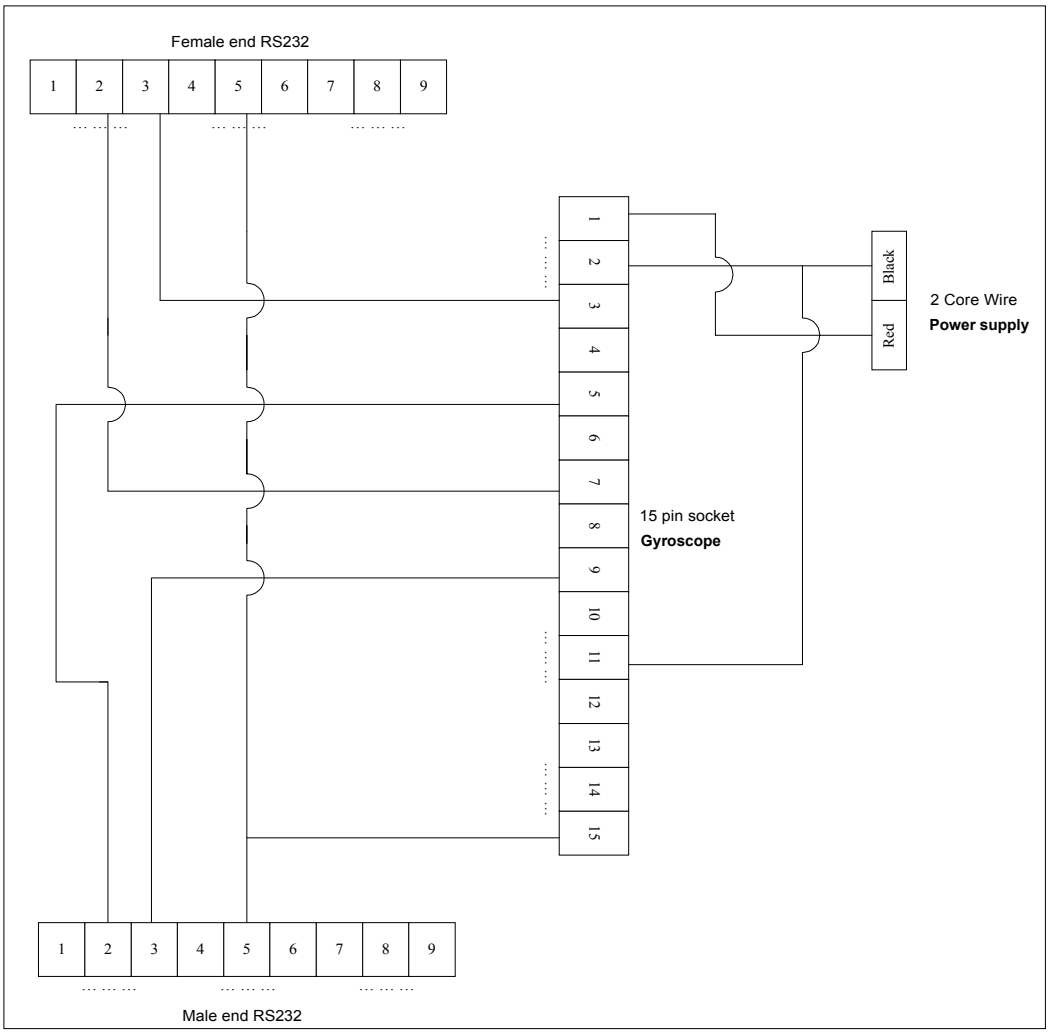
5. Brown
9. Red
15. Yellow

Male end of RS232 Cable

15. Yellow
7. Brown
3. Red

Female end of RS232 Cable

© 2001 Data Collection Ltd.



Gyroscope Connections

ROMDAS PARTS

The following are the standard parts used in ROMDAS:

- **Bump Integrator Encoder** – HP hollow shaft encoder – Radio Spares part number 205-6869
- **High Resolution Distance Measurement InstrumentEncoder (v 3)** – Stegmann DG60L XKR 360 pulses/rev 4-6 v DC
- **High Resolution Distance Measurement Instrument Encoder (v 2)** – HP Panel Mounted Encoder – Radio Spares part number 205-6853
- **High Resolution Distance Measurement Instrument (v 1) Electronics Enclosure** – Radio Spares part 502332
- **TPL Master Controller Enclosure** – Radio Spares part 225237
- **Power Distribution Box – v 1**
    - SPST Switch – DSE Part P-7668
    - Screw Cap Fuse Holder – DSE Part P-7902
    - 12 v Bezel Light – DSE Part P-8100

© 2001 Data Collection Ltd.

- Replacement Globe for Bezel Light – DSE Part P-8155
- 2.1 mm Socket Single Hole DC Power Socket – DSE Part P-1648
- Aluminium Die Cast Box – DSE Part H-2229

© 2001 Data Collection Ltd.

ANNEX E DISTANCE/SPEED SENSOR INSTALLATION INSTRUCTIONS

There are three types of standard distance/speed sensors available for use with ROMDAS:

- **Splice-in Speedometer Cable Sensor**. This is spliced into the speedometer cable housing with the existing speedometer cable running through the centre of the sensor.
- **Gearbox Speedometer Cable Sensor**. This is also used with speedometer cables but connects at the junction between the speedometer cable and the transmission. It fits most modern Japanese vehicles and screws directly to the transmission. The speedometer cable is then connected to the sensor. It is fast and easy to fit but it does not fit all vehicles.
- **Electronic Speedometer Sensor**. This is used in vehicles which have electronic speedometers. It monitors the pulse line and returns a signal for each pulse. This works on most vehicles with the only problems reported with a Nissan utility.

These sensors are illustrated in the following photograph.

ROMDAS comes standard with the mechanical splice-in speedometer sensor. There is also an optional high resolution distance measuring instrument (DMI) available.

This annex presents the manufacturers recommendations for installing the distance/speed sensors.
It should be noted that ROMDAS is very accommodating when it comes to odometer sensors. Almost any system which can give a pulse can be used. The sensor only needs to create connection for the BLUE and GREEN wires for it to be suitable.

© 2001 Data Collection Ltd.

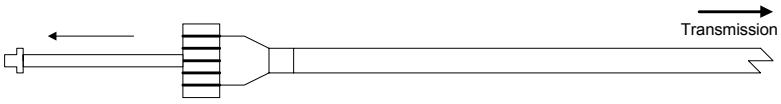
PROBLEMS

The ROMDAS speed/distance sensors have been fitted to a range of vehicles without any problems. The only make of vehicles where problems have been reported is one from Nissan with an electronic speedometer. The reason for this is that the signal pulse is so small the electronic sensors cannot differentiate the signal from background noise. In this case we suggest a simple magnetic sensor be fabricated from the standard security sensors and attached to the drive line.

© 2001 Data Collection Ltd.

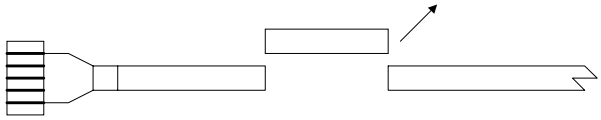
ANNEX E.1: SPLICE IN SPEED/DISTANCE SENSOR INSTALLATION INSTRUCTIONS

1. Disconnect speedometer cable from speedometer and transmission and remove inner core. If the core cannot be pulled through the cable housing you cannot use the splice in sensor.

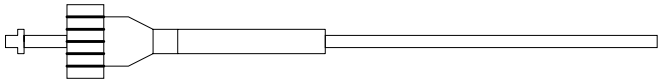


2. Select an appropriate location for the sensor (best done BEFORE disconnecting the cable) and using a fine tooth hacksaw remove 15 mm of the cable housing.

3. Remove any burrs from the sheath ends where the cuts were made.



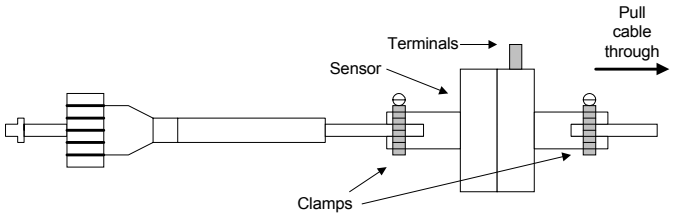
4. Wipe off any excess oil or grease from the cable core and replace into the speedometer end of the cable.



5. Place speed sensor cable clamps (2) on both ends of the speed sensor.

6. Insert loose end of the speedometer core cable into the END of the speed sensor and push through the sensor's internal friction bushing until the speedometer end of the cable housing is fully seated in the sensor. If the diameter of the cable is too small you may need to apply tape to build it up.

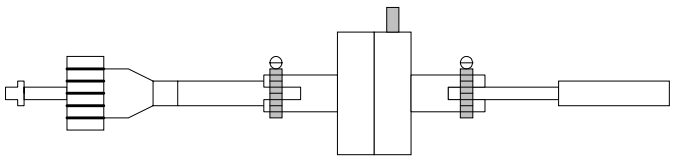
7. Tighten the end of the clamp. DO NOT OVERTIGHTEN.



8. Feed the loose cable core end into the long housing section until the housing is firmly seated in the speed sensor.

9. Tighten the end of the clamp. DO NOT OVERTIGHTEN.

10. Check that the cable rotates freely. Reconnect to the transmission and speedometer.



NOTES

1. Failure to wipe off excess oil from the inner core may render the sensor unworkable.
2. Over-tightening of the sensor clamps will lead to speedometer oscillation or excessive wear.
3. Sensor is not designed to tolerate 'end thrust' which could result from the use of a worn cable that allows the inner to slide up and down within the sensor.
4. Do not fit the sensor on a bend in the cable.

© 2001 Data Collection Ltd.

ANNEX E.2 ELECTRONIC SPEED/DISTANCE SENSOR INSTALLATION INSTRUCTIONS

This sensor provides an interface between electronic speedometer/odometers and ROMDAS. At the bottom of this page is given a wiring diagram for the sensor.

1. Disconnect the vehicle's electronic speedometer sensor from the gearbox.

2. It is necessary to locate the 'pulse' wire in the loom which feeds the sensor.

3. To do this, leave the sensor wired up and have the vehicle's ignition switch 'ON'.

4. Connect a voltmeter between each wire and ground, then rotate the sensor. The voltmeter will register as follows for each of the wires in the vehicle:

   (a) Supply : Voltmeter reads volts constantly (probably 12 volts)
   (b) Ground: Voltmeter reads '0' volts constantly
   (c) Pulse : Voltmeter 'pulses' between a voltage and '0' as sensor is turned.

5. Once the 'pulse' wire has been located, simply run a wire off this 'pulse' wire and connect it to the ROMDAS electronic sensor. The connection is made in parallel so all the original sensor connections remain.

6. Fit the sensor in a convenient place under the dashboard.

The standard ROMDAS speedometer sensor comes with the cable connected. For situations where these do not work a Brantz sensor is provided along with a connecting cable. The wiring for this sensor is illustrated below.

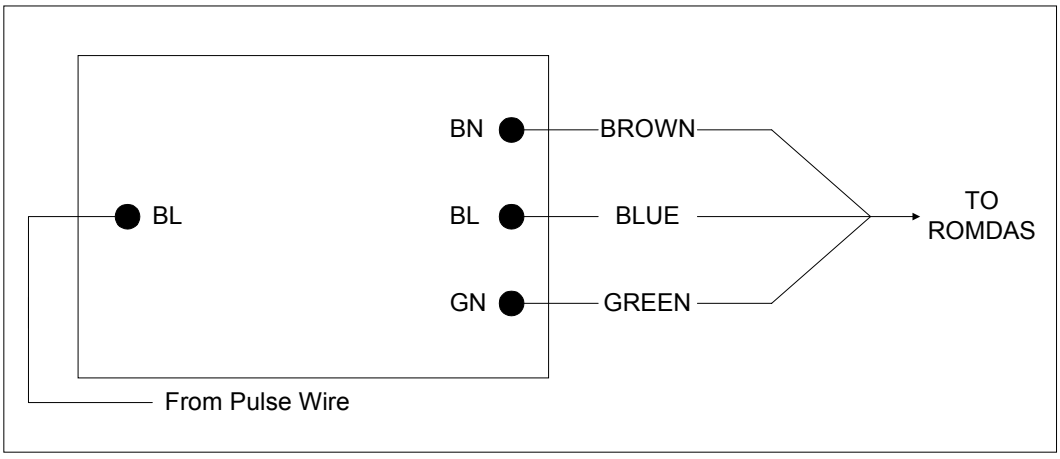


Figure E.2.1: Brantz Electronic Speedometer Sensor Wiring Diagram

© 2001 Data Collection Ltd.

ANNEX E.3 TRANSMISSION SCREW-IN SPEED/DISTANCE SENSOR INSTALLATION INSTRUCTIONS

The transmission screw-in sensor is used for speedometer cable equipped vehicles where it is not possible to extract the speedometer cable from the housing to use the in-line sensor.

The sensor will fit **most** Japanese vehicles with cable driven sensors. There are three components:

- the sensor which has a thread on one end and a screw-in connector on the other;
- a 'drive pin' which connects to the screw-in connector end of the sensor;
- a 3 hole connection block.

The sensor is installed as follows.

1. Unscrew the speedometer cable from the transmission. The end of the cable should have a flattened side which is the same size as the drive pin.

2. Connect the speedometer cable to the sensor and tighten. The flattened side of the cable should fit into the notch in the end of the sensor.

3. Insert the drive pin into the front of the sensor.

4. Check the cable and sensor turn freely by turning the drive pin.

5. Check the location of the notch in the transmission where the drive pin will be inserted. Rotate the drive pin so that it is correctly aligned.

6. Connect the sensor to the gearbox.

7. Connect the sensor wires to the ROMDAS speedometer cable.

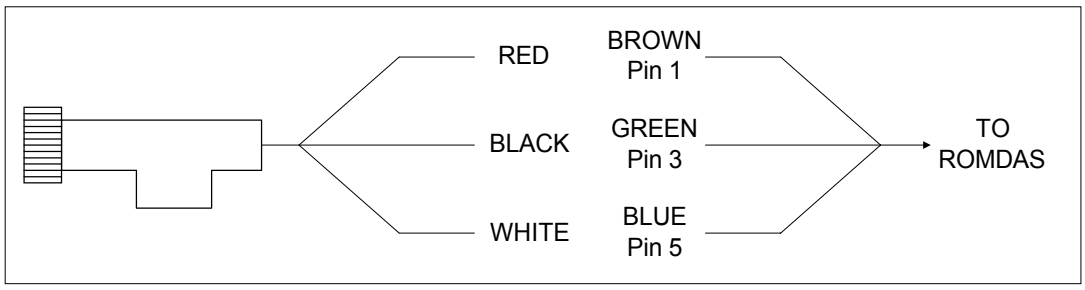


Figure E.3.1: Screw-in Speedometer Sensor Wiring Diagram

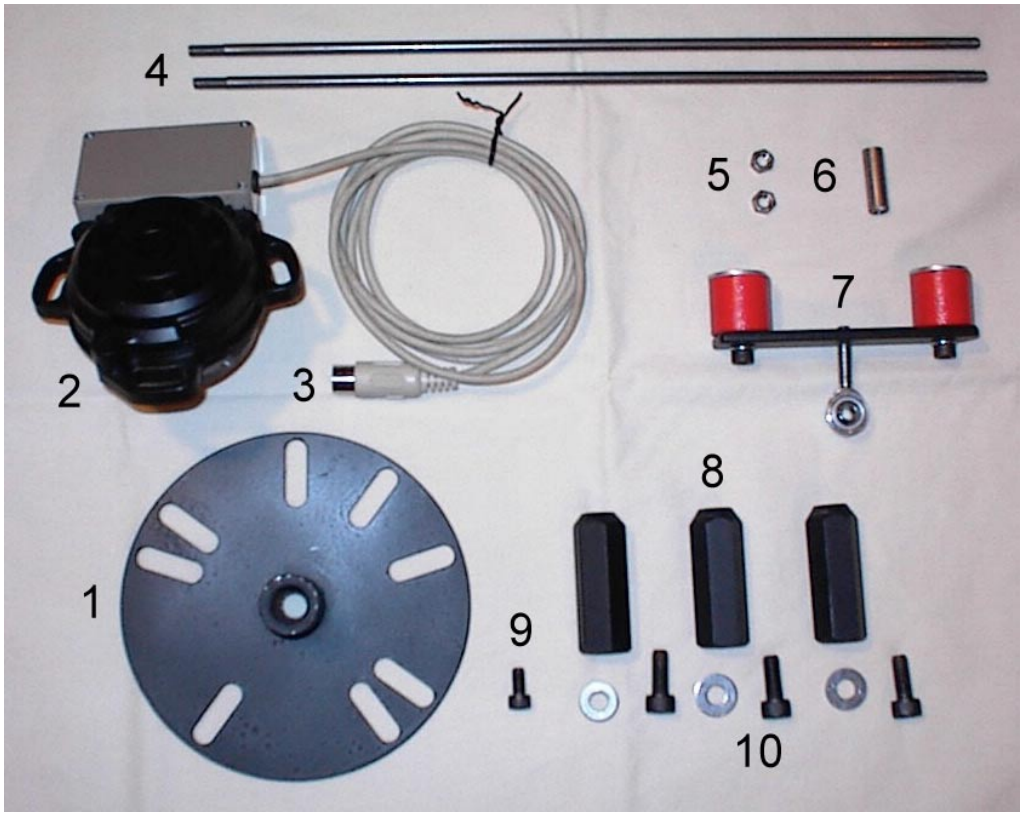
© 2001 Data Collection Ltd.

ANNEX E.4 ROMDAS HIGH RESOLUTION SENSOR

The ROMDAS high resolution DMI sensor (HRDMI) has been developed for applications where high distance accuracy is required or where the other sensors (*eg* the electronic sensor) cannot be readily fitted or made to work. The sensor returns 360 pulses per wheel revolution, giving a typical distance of 0.007 m per pulse, or over 150,000 pulses per km. By comparison, the standard sensors only give 2,000 - 5,000 pules per km, depending upon the vehicle's equipment.

The v 1 HRDMI components are shown in the following photo. The components numbered in this figure are:

1	Wheel Plate
2	Electronic Transducer
3	Transducer to ROMDAS Cable
4	2 x Stabilisation Rod
5	2 x Stabilisation Road Nuts
6	Stabilisation Rod Joiner
7	Magnetic or Suction Holder
8	Wheel Nut Extenders
9	Transducer – Wheel Plate Retaining Screw
10	Wheel Plate – Wheel Nut Screws and Washers

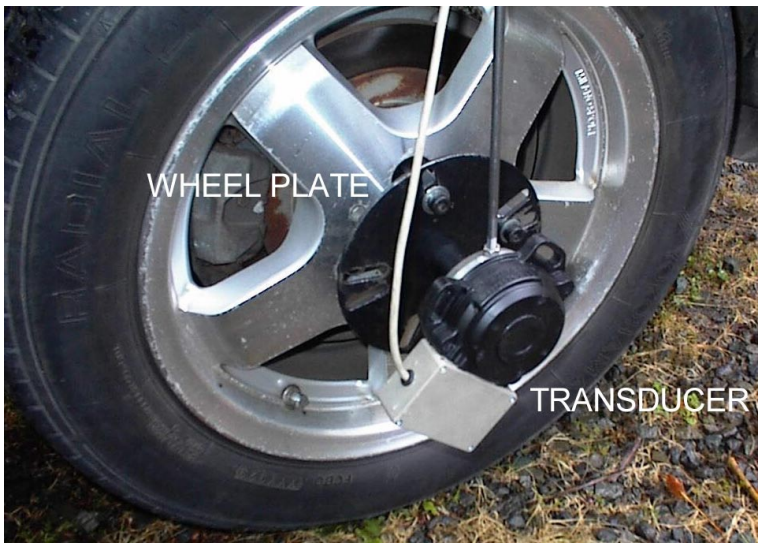


The v 2 HRDMI has the same basic components except the transducer (#9) is smaller and encased in a small aluminium housing. This uses a standard panel mount encoder (Radio Spares part 205-6853) instead of the custom encoder used in the v 1 HRDMI.

Installation of the HRDMI is as follows:

© 2001 Data Collection Ltd.

1. Replacing three of the existing wheel nuts with the wheel nut extenders (#8).
2. Attach the HRDMI wheel plate (#1) to the extenders with the three screws (#10). The centre of the plate should be located in the centre of the wheel. The plate has been designed so that it will fit almost any wheel configuration and effectively be self-centring. Should this not be the case it is necessary to cut additional slots to the plate to match your wheel nut configuration.
3. Insert the electronic transducer (#2) into the wheel plate. The transducer shaft is grooved and the retaining screw (#9) should be tightened into the slot. Should the transducer be difficult to remove from the plate, a hole is provided in the back of the plate and the shaft can be hammered out gently. Once fitted, the plate and transducer will be as shown in the following photo.



4. The electronic transducer rotates freely so it is necessary to stabilise it in one place. This is done using the stabilisation rods (#4) and the magnetic holder (#7). The stabilisation rod can be vertical, horizontal or on an angle. You should test which is the best configuration.
5. Fit a nut (#5) to one end of a stabilisation rod (#4) and screw to the end of the threads.
6. Insert the end of the stabilisation rod with the nut into the threaded hole in the electronic transducer. If possible, silicon, LockTite, or some other sealant should be used in the hole so that water does not enter the transducer.
7. Tighten the nut against the transducer so that the stabilisation rod is held in place tightly. If the rod has not been sealed in place you should use a lock washer (not included) to ensure a tight fit.
8. Remove the two metal protection plates on the end of the red magnets on the magnetic holder (#7).
9. Insert the other end of the stabilisation rod through the ball joint in the magnetic holder (#7). If the rod is too short, it can be extended using the joiner (#6) and the second rod.
10. The magnetic holder should then be placed on the side of the vehicle on a flat part of the body. It is recommended that a wire be connected to the holder and tied to the vehicle so that should the magnets come off the holder will not be lost.
11. Fit another nut to the end of the stabilisation rod that has been passed through the magnetic holder and tighten. This will help to prevent losing any components should they become loose.
12. Run the transducer to ROMDAS cable (#3) along the rod and tie it loosely in place. This should be connected to the ROMDAS either directly or through an extension cable. Once installed the final system will be as shown in the following photo.

© 2001 Data Collection Ltd.

NOTE: The stabilisation rods must be mounted so that they are **vertical** in line with the suspension movement otherwise extra pulses will be generated unrelated to forward movement of the vehicle.

Figure E.4.1 shows the wiring connections for the v 1 HRDMI electronic transducer. If these do not work try reversing the signal and earth by 180°. Figure E.4.2 shows the same for the v 2 HRDMI transducer. The v 3 HRDMI transducer is the yellow Stegmann encoder which has the following connections:

Stegmann High Resolution DMI Encoder

Pin 1 -	Red	+5 v Power
Pin 3 -	Blue	Earth
Pin 5 -	Black	Signal

© 2001 Data Collection Ltd.

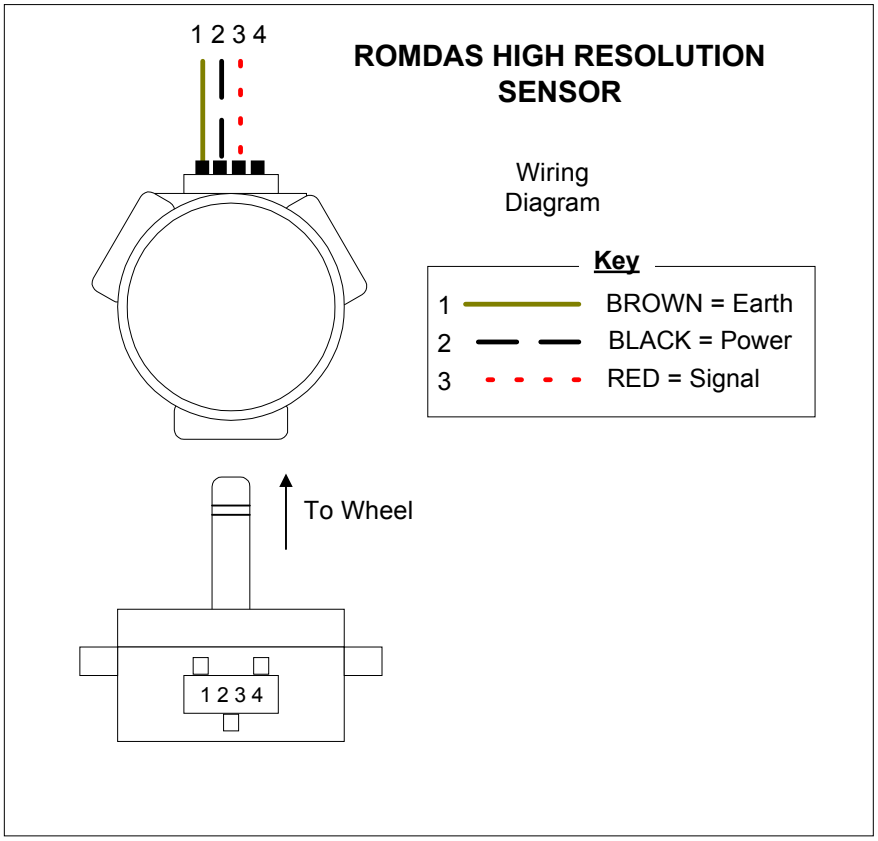


Figure E.4.1: ROMDAS v 1 High Resolution DMI Sensor Wiring Diagram

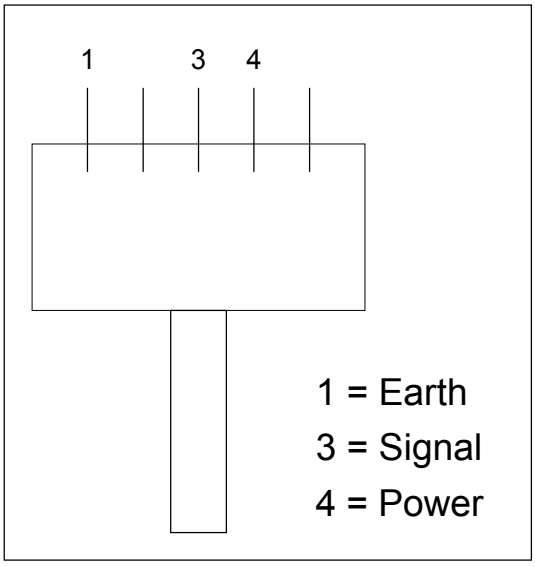


Figure E.4.2: ROMDAS v 2 High Resolution DMI Sensor Wiring Diagram

© 2001 Data Collection Ltd.

ANNEX F INSTALLATION OF ROUGHNESS METER

ROMDAS BUMP INTEGRATOR

The ROMDAS BI is illustrated in Figure F.1. It is installed in the rear of the vehicle but is small enough to be relatively unobtrusive (see Figure F.2).

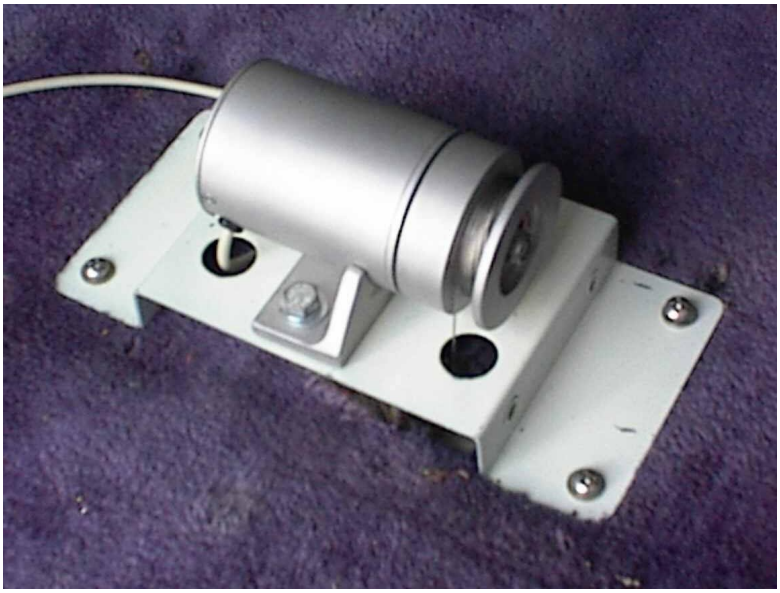


Figure F.1: ROMDAS BI and Mounting Plate

Figure F.2: ROMDAS BI Installed in Vehicle With Protective Cover Off

The BI comes with an installation kit consisting of a base plate and a protective cover. The base plate is attached to the floor of the vehicle via screws or bolts (not supplied). The BI is then mounted to the base plate. The cable and the BI wire are fed through holes in the base plate and the protective cover is then fitted. Figure F.3 shows a cross-section of the BI with the protective cover in place.

© 2001 Data Collection Ltd.

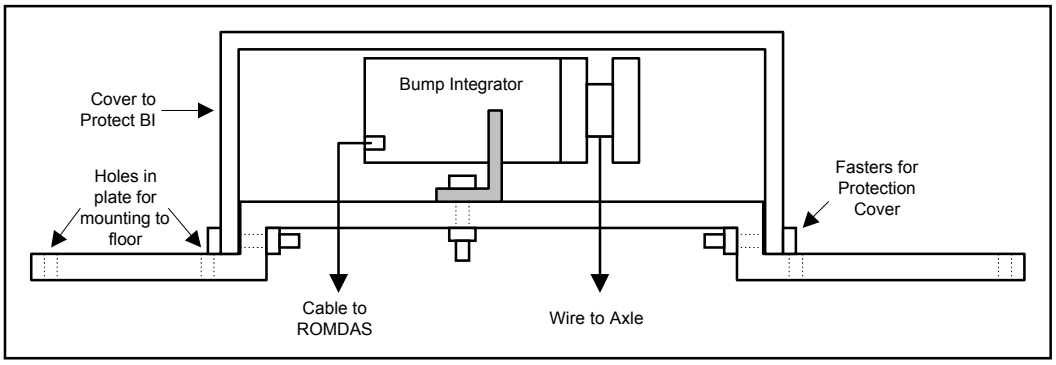


Figure F.3: Cross-section of ROMDAS BI When Installed

If two BI units are to be installed, the ROMDAS v 5 hardware must be used. This has a BI port for each if the BIs. When using dual BI's it is VITAL that you confirm which is returning data to the BI-1 connection. This is best done by installing the dual BI system as described earlier and then disconnecting one of the BI units. Connect the ROMDAS simulator to the ODO connection on ROMDAS and start a roughness survey with BI-1 connected. The data displayed should be the left of the two numbers and this corresponds to the left hand wheelpath when driving along the road.

When calibrating the roughness meter (see ANNEX J) the calibrated roughness will be established for each wheelpath and the appropriate wheelpath used with the corresponding BI.

As shown in Figure F.4 there are several options for installing the BI in a vehicle:

- **Solid Rear Axle**. If the vehicle has a solid rear axle it should be installed over the centre of the differential. This will measure what is termed a 'Half-Car' roughness.
- **Independent Rear Suspension - 2 BI Units**. If there is an independent rear suspension it is recommended that two BI units be installed: one for each wheelpath. Each of these will measure a 'Quarter-Car'. The average of these two will give the overall roughness.
- **Independent Rear Suspension - 1 BI Unit**. The use of 1 BI unit with an independent rear suspension is possible, but not recommended. This is because the vehicle will still measure a 'Quarter-Car' but the roughness measurements will be dominated by the roughness in the single wheelpath—it does not matter which one—being monitored. It will prove difficult to have a good calibration of the meter because the roughnesses will vary between wheelpaths and between test sections.

The fixing point for the BI should always be along the centreline of the axle. If there is an independent rear suspension it should be along the line of the drive shafts. When mounting with a solid rear axle the fixing point should be along the vehicle centreline (see Figure F.5. With an independent rear suspension the fixing point will depend upon the suspension design and geometry. It is important that if dual BI units are used the fixing points should be in identical locations.

The BI is usually fixed to the vehicle via a cable and wire hook, although other options than the hook can be used: all that is required is that the wire be firmly fixed to the suspension. Modifications may be required with independent rear suspensions where there is not a good location for installing the hook. The hook should be installed in the appropriate location and bent so that it will hold the end of the wire.

© 2001 Data Collection Ltd.

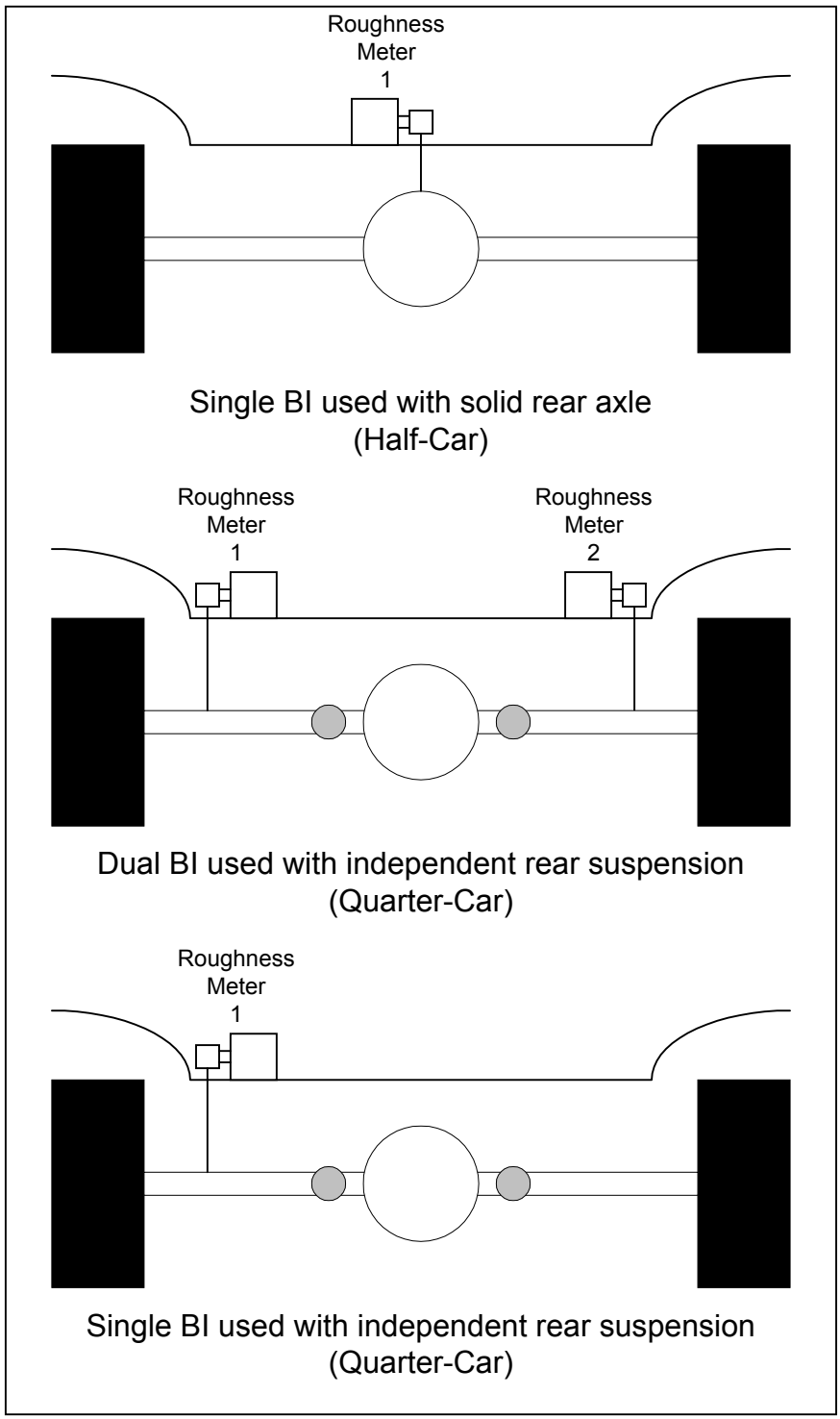


Figure F.4: Installation Options For BI

© 2001 Data Collection Ltd.

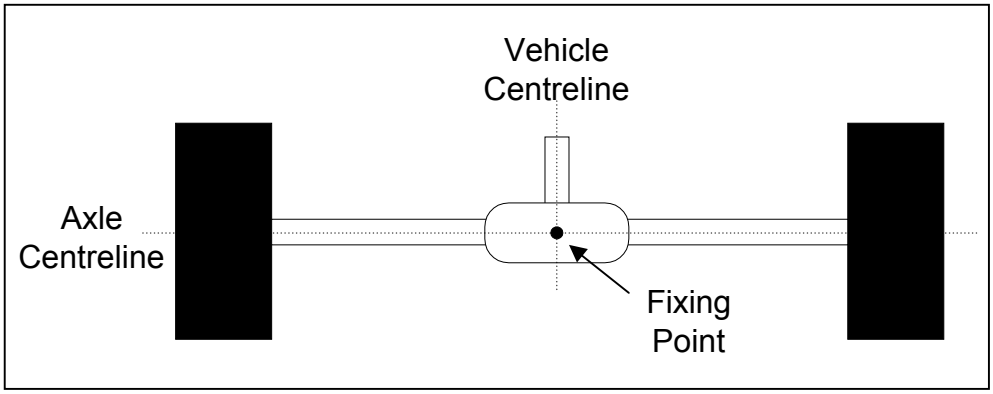


Figure F.5: Location of Fixing Point

The wire should be threaded through the supplied connector to form a loop as shown in Figure F.6 These connectors are readily available from most electrical suppliers: they are used in 'Fuse Blocks'. The loop must be tight so that there is no flex in the cable.

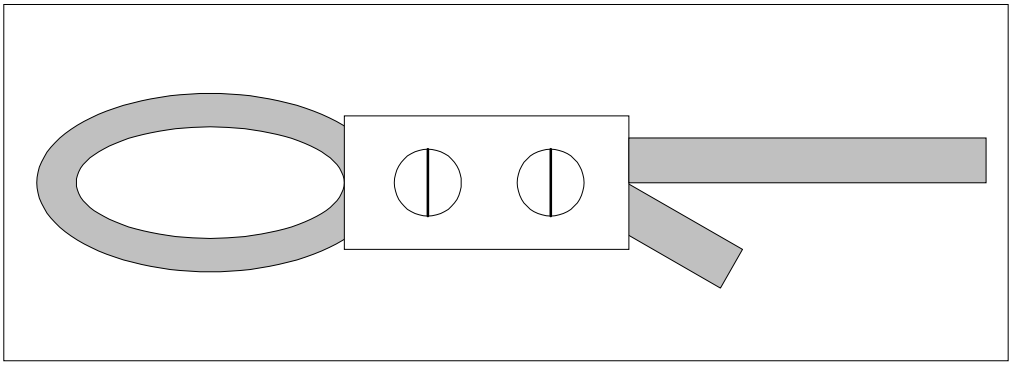


Figure F.6: Looped Wire

A metal plate is supplied with a rod welded to the plate. This should be attached to the differential and the road bent into a 'hook' (see the figure in the following section under TRL BI).

Installation usually requires two people. The BI contains a spring which is pre-tensioned by winding it **COUNTERCLOCKWISE IN THE DIRECTION OF THE ARROW** a **MAXIMUM** of 2.5 revolutions. **DO NOT OVERTIGHTEN.**

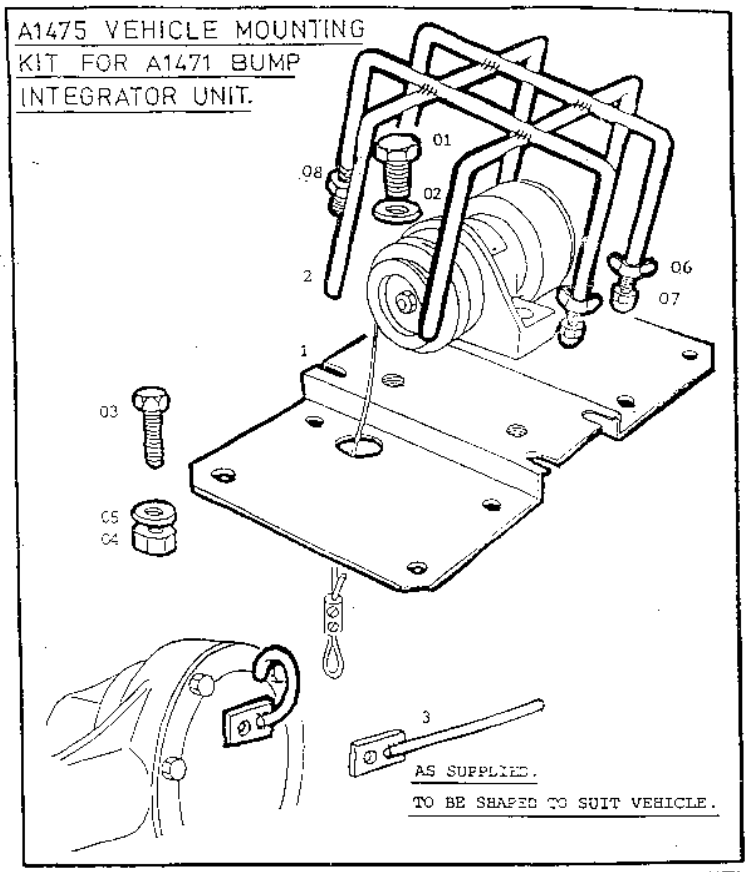
While this is held in place, the wire is lowered through a 25 mm hole and connected to the hook. The wire is pulled through the connector so that it is snug with the hook. The screws are then tightened and the BI is released. The spring should take up the tension in the BI wire. Pushing up and down on the rear of the car should result in the BI moving as it responds to the vertical motion.

© 2001 Data Collection Ltd.

TRL BUMP INTEGRATOR

LEONARD FARNELL & CO LTD.
NORTH MYMMS HATFIELD HERTS AL9 7SR ENGLAND

A1475 VEHICLE MOUNTING KIT FOR A1471 BUMP INTEGRATOR UNIT.



AS SUPPLIED.
TO BE SHAPED TO SUIT VEHICLE.

ITEM	QTY	DESCRIPTION	PART No	
1	1	MOUNTING PLATE	B2066-I.	ASSEMBLED TOGETHER.
2	1	GUARD	B2067-I	
3	1	WIRE HOOK	AA225	SUPPLY IN POLLY: BAG.
01	2	HEX SET SCREW	M10x30	
02	2	FLAT WASHER	M10	
03	4	HEX SET SCREW	M6x25	
04	4	NUT	M6	
05	4	FLAT WASHER	M6	
06	2	WING NUT	1/4 BSF	ASSEMBLED ONTO ITEM 2.
07	2	DOME NUT	1/4 BSF	
08	2	NUT	1/4 BSF	

STEVENS FARNELL
QUALITY AND TEST SYSTEMS

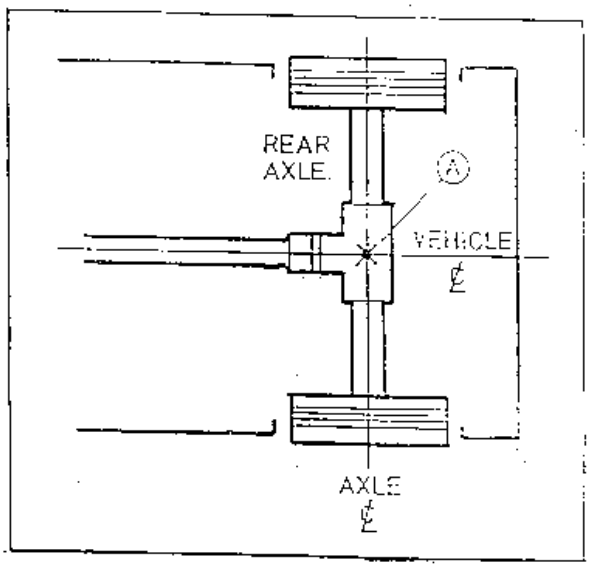
LEONARD FARNELL & CO. LTD.,
HATFIELD,
HERTS., ENGLAND. AL9 7SR.
Tel: (0707) 264488 Fax: (0707) 269247

© 2001 Data Collection Ltd.

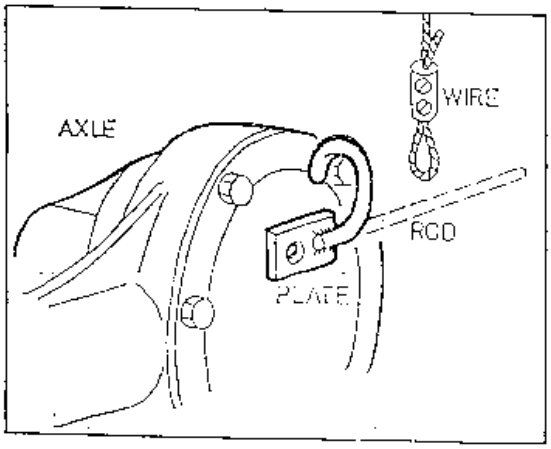
A1476 WIRE HOOK FOR BUMP INTEGRATOR.

Due to variations in vehicles used for this equipment the wire hook will have to be individually fitted and although this has been found to satisfy most cases, changing vehicle design could require a different means of anchoring the integrator wire.

Find a suitable fixing point on vehicle rear axle (transverse differential type or transverse beam if front wheel drive) as near as possible to axle/vehicle centre line 'A'.



Offer plate to fixing, bend and trim rod to form hook to pick up integrator wire as near to point 'A' as possible. With hook in position cut a 25mm dia hole in vehicle floor for wire access.



STEVENS
FARNELL
QUALITY AND TEST SYSTEMS

LEONARD FARNELL & CO. LTD.,
STATION ROAD, NORTH MYMMS.
HATFIELD, HERTS.,
ENGLAND, AL9 7SR.
Tel: (01707) 20...
Fax (01...

© 2001 Data Collection Ltd.

ANNEX G TRANSVERSE PROFILE LOGGER

INTRODUCTION

The ROMDAS Transverse Profile Logger (TPL) consists of a series of ultrasonic sensors housed in a 'bar' which is affixed to the front of the vehicle. The sensors emit sound pulses and the distance of each sensor from the pavement is established from the time it takes for the pulse to travel to and from the pavement.

The TPL sensors are contained in ultrasonic measurement sensor arrays (UMSA). These consist of 5 sensors in an aluminium housing. The arrays are fired sequentially and the data is stored in the master controller for future downloading (see Chapter 11).

This annex describes the TPL, its installation and technical details on its operation. Chapter 11 describes TPL surveys. ANNEX N contains step-by-step instructions for calibrating the TPL.

INSTALLING THE TPL

The TPL is supplied either as the electronics only or as the electronics plus bar. If you have purchased the electronics only it will be necessary to fabricate your own bar. This can be fabricated from metal or very strong wood. The only requirement is that holes be drilled to match the bolts on the UMSA and that these be spaced with 100 mm between adjacent UMSA sensors. Once completed, the installation is the same as described below.

The ROMDAS TPL bar is fabricated from aluminium and comes with the UMSA holes pre drilled. The UMSA are labelled with the Node number (1 to 6) and the sensor numbers (1 to 30). Before installing the bar on the vehicle ensure that the node numbers are increasing sequentially from the kerb side of the vehicle to the centreline side, and that the numbers are also increasing sequentially as well. This is illustrated in Figure G.1. **Sensor 1 and Node 1 must be at the kerb.**

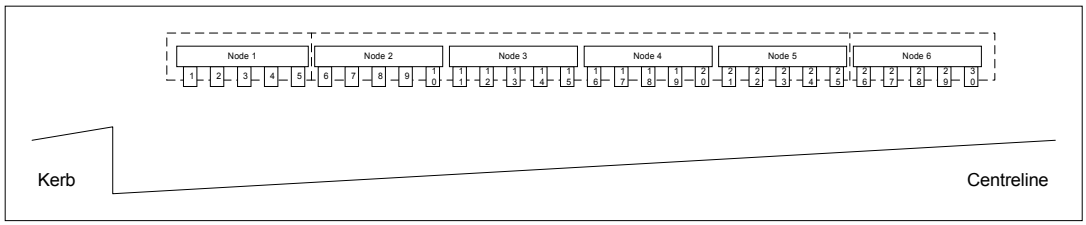


Figure G.1: UMSA Installation Order

At the end of each UMSA there is a 9 pin RS-232 type cable. The sensors are connected sequentially to each other in a continuous 'chain'. The cable at the end of Node 1, Sensor 1 is connected to the 'Master Controller' which should be installed in the vehicle (see below).

Each pair of serial plugs should be placed inside of the 'environmental enclosures'. These are small boxes which are notched at each end. The lid of the box should be removed, the cables inserted through each end, and the lid replaced. All gaps should be sealed with silicone sealant.

© 2001 Data Collection Ltd.

The Master Controller (MC) is a small aluminium box which is connected to the computer and the first node. When a signal is received from the PC, the MC fires the UMSA sensors and then stores the data for future downloading. As shown in ANNEX C, power should be supplied to the MC. If the notebook does not contain two serial ports, a PCMCIA serial port should be used. ANNEX R describes how these devices are installed.

NOTE: The wire from the TPL to MC should be clear of any high tension lines in the vehicle.

ATTACHING THE BAR TO THE VEHICLE

The ROMDAS TPL consists of a main 2 m section with two 500 mm 'wings'. The wings are removable/retractable.

The ROMDAS TPL bar contains a steel plate on the back with high tensile lugs. The bumper should be drilled and the lugs inserted through the holes and bolted. The bar should be mounted so that the sensors are 350-450 mm above the pavement surface. If the sensors are outside of this range problems with the readings may arise on certain pavements.

SETUP OF THE SYSTEM

The following is the process to be followed to setup the TPL.

1. DEVELOP CALIBRATION EQUATION

The calibration equation is used to correct the TPL predictions so that they correspond to a known distance.

Note: It is only necessary to do this analysis for one sensor, although it may be repeated for multiple sensors and the results averaged.

EQUIPMENT:

- tape measure
- an object with a vertical face (e.g. 3.5" plastic floppy disk box)

PRELIMINARY SETUP

1. Set up one of the TPL sensors in a room along with the fixed sensor and connect to the ROMDAS interface and notebook computer.
2. Select **SETUP|CALIBRATE|CALIBRATE TRANSVERSE PROFILE LOGGER|MULTIPLE MEASUREMENTS**.
3. Enter a description of the calibration test and the file name.
4. Start the sensor recording.

MEASUREMENT DATA

1. Place the tape measure perpendicular to one of the UMS transducers with the 0 value at the edge of the UMS.
2. Place the object at a distance of approximately 250 mm on the tape.

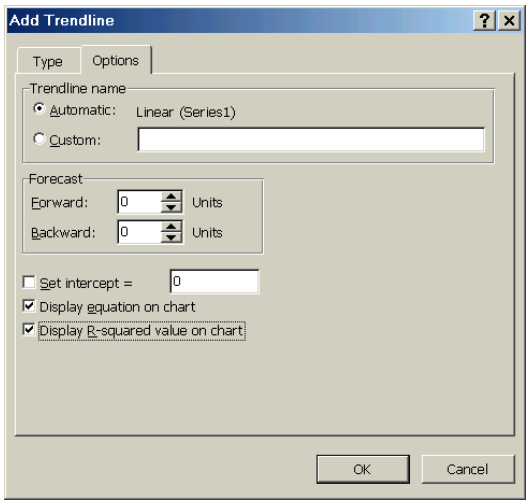
© 2001 Data Collection Ltd.

3. Record the distance displayed on the computer and the distance of the fixed sensor. Also enter the actual distance (it is not necessary to be exactly 250 mm).
4. Move the object to 275 mm on the tape and note the distances.
5. Repeat step 4 every 25 mm until 500 mm of data have been collected.

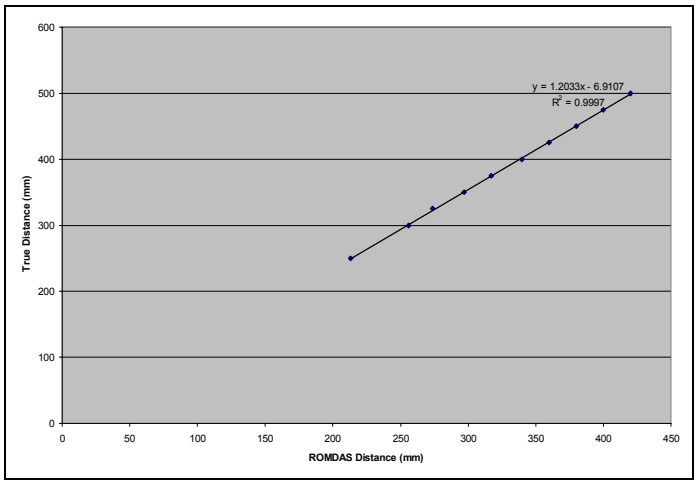
Note: There must be only a single value for the standard conditions for all measurements.

DEVELOP REGRESSION EQUATION

1. Start Microsoft Excel (or similar)
2. On a workbook enter the measurement data with the actual measured distances in the first column, and the predicted distances in the second column. Place the temperature sensor values in the third column.
3. Highlight the first two columns and select to create an X-Y scatter plot graph**.**
4. Once the data are plotted, right click on the plotted series and select **Add Trendline**.
5. Ensure that the trendline is linear.
6. Under options select **Display Equation on Chart** and **Display R-squared on Chart** (see below).



7. Select **OK** and the regression line will be fitted (see below). It should be of the form DISTANCE = A + B ELEVATION, where DISTANCE is the measured distance in mm and ELEVATION is the TPL elevation.



© 2001 Data Collection Ltd.

8. Record the values for the constant and slope.
9. Record the average value for the standard conditions.
10. Repeat for other sensors and calculate the average constants, slopes and temperature sensor readings. These values should all be similar. If not, contact DCL.
11. Enter the values for the constant and the slope under **SETUP|TRANSVERSE PROFILE LOGGER** TPL Measurement Calibration Coefficients.
12. Enter the average temperature sensor value under **SETUP|TRANSVERSE PROFILE LOGGER**

2. DISTANCE BETWEEN SENSORS IN TPL HOUSING

Install the sensors into the TPL housing ("bar"). Measure the distance between the sensors on the adjacent arrays. This should be approximately 100 mm. Under **SETUP|TRANSVERSE PROFILE LOGGER** enter the distances.

3. CREATE DATUM LEVEL

The datum level is used to correct for differences in the elevations between adjacent sensors.

1. Install the TPL on the vehicle.
2. Park the vehicle over a trough of water so that the TPL has a clear 'shot' at the water. The photograph below shows a TPL over a simple water trough. A frame is placed on the ground and a sheet of plastic draped over the frame. The frame is then filled with water. This gives a perfectly level surface for the TPL calibration.

TPL Calibration Using Trough of Water

© 2001 Data Collection Ltd.

3. Run **SETUP|CALIBRATION|TRANSVERSE PROFILE LOGGER|MULTIPLE MEASUREMENTS**. This will take a series of readings on the water.
4. Run **SETUP|CALIBRATION|TRANSVERSE PROFILE LOGGER|CREATE DATUM FILE**. Select the file of the straight-edge measurements and create a datum level file. This will give correction factors for the sensors relative to each other.

4. TPL Sensor Numbering

The TPL sensors must be numbered sequentially from kerb to centreline across the TPL housing. If this is not done the software will incorrectly report the rutting in the left and right wheelpaths. It is also essential that they numbering be sequential (1 to 30) otherwise the calculations will be wrong.

There are two steps in the process:

- Ensure that sensor 1 is at the vehicle kerb.
- Ensure that the numbering is sequential.

Ensure Sensor 1 is at the Kerb/Edge of Road

This is done with the TPL mounted on the vehicle and both wings extended. The process is as follows:

1. Start **SETUP|CHECK TPL SENSOR NUMBERING**. The screen will display the elevation readings for each sensor.
2. Have an assistant go to the sensor which is closest to the vehicle kerb and put a hand over the foam cover on the sensor.
3. If the arrays are in the correct order, either sensor number 1 or 5 will go to 0. No further actions are required.
4. However, if sensor 26 or 30 goes to 0 the arrays are reversed. Press the F8 key to invert the order of the arrays. When this is pressed what was array 6 goes to 1; 5 to 2; 4 to 3; 3 to 4; 2 to 5 and 1 to 6.
5. Repeat step 3 to confirm that the arrays have been correctly reversed.

Ensure Sequential Numbering

There are two stages to sequential numbering. Firstly, one must ensure that the sensors are correctly ordered from 1 to 6 (*i.e.* 1-2-3-4-5-6 not, for example, 1-3-2-4-5-6). This is done by starting **SETUP|CHECK TPL SENSOR NUMBERING** and having an assistant place their hand under each of the arrays. The values on the array will change and it can be confirmed that they are in the correct order.

NOTE: The TPL sensor numbers are stored in the file TPLORDER which is in the directory where the ROMDAS software is run from. This file must be present for the calculations to be correct. If the ROMDAS software is moved to another directory the file must be moved with it.

© 2001 Data Collection Ltd.

DIAGNOSTICS

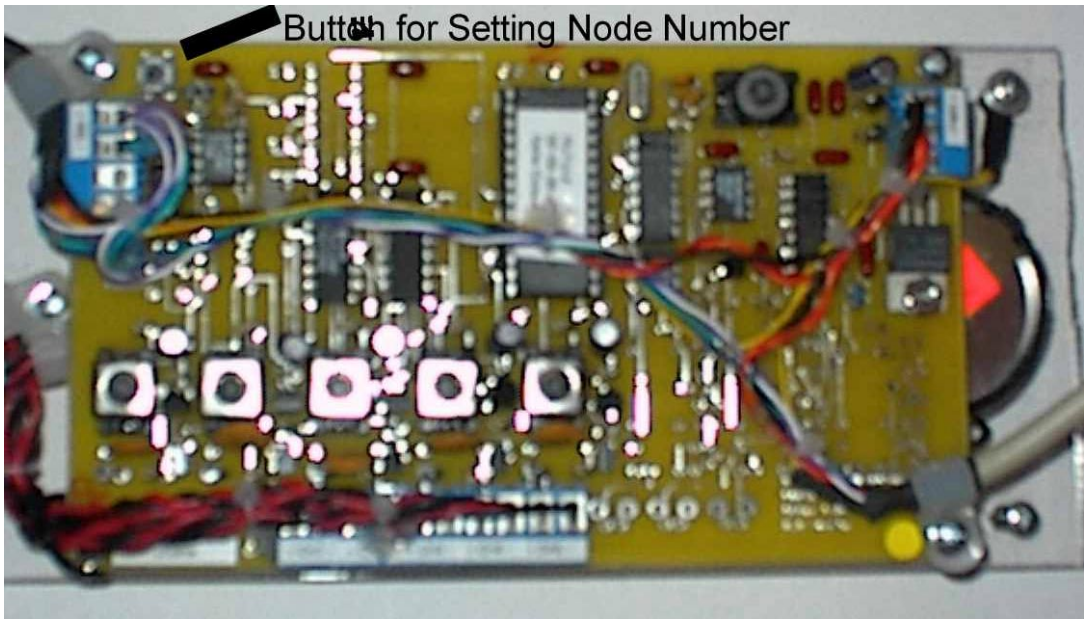
The TPL Logger has diagnostics routines under the **SETUP|TPL|TPL DIAGNOSTICS**. These are the same as the diagnostic routines on the basic program accompanying the TPL but the basic program should be used if possible since the code will be the most up to date for your TPL.

Set Node Number

The most common activity is to set the node number. This needs to be done when you are in the field and a sensor fails. The steps in involved are as follows:

1. The TPL node number reset button is installed on the board in the early units, and is at the side in later units. The side mounted buttons are accessed by taking off an end plate and locating the button. With earlier units, you must open up the UMSA and **CAREFULLY** remove the board. It is necessary to remove the end plates from both ends and pull the board out from the end with the circuits on top.
2. Connect the UMSA to the Master Controller.
3. Run the TPL BASIC test program or ROMDAS.
4. Select SET NODE NUMBER (S in the BASIC program) and enter the new node number (1 to 6). The screen should have a series of rows with:
   .1
   .1
   .1
   etc.
5. Push the button on the UMSA board and you will see the number entered in 4. above on the screen (*e.g.* a sequence with .1 .1 .1 .6 .1 .1). This is an acknowledgement that the new node number has been accepted. The figure below shows the location of the button on the early TPL boards.
6. Test that the sensor has been assigned the correct node by running the ROMDAS or BASIC measurement option.

This option is used to set the node number of each array. The numbering is as shown in Figure G.1. The node is set by plugging the array directly into the computer and then redefining the number.



© 2001 Data Collection Ltd.

From late 1999 this button is located on the side of the board so is accessible by simply removing the end plate.

Gain Set

The gain dictates the sensitivity of the ultrasonics sensors. The values range from 5 to 30 with the higher the number the higher the sensitivity. The gain is set by defining both the node and the gain.

The gain setting on the temperature sensor is adjusted by first removing the electronics unit from the tube. These are held in place by silicon so one simply needs to twist and gently pull the end with the cable from the tube. There is a small white one turn potentiometer on the circuit board. Turning this pot counterclockwise reduces the sensitivity and turning it clockwise increases the sensitivity. It is a one-turn pot. If the sensitivity is too low then the fixed target will not be seen. If the sensitivity is too high then the sensor will give unstable readings. The distance measurement may jump around a bit. The setting is therefore established through a process of trial and error. It is necessary to run ROMDAS with the TPL calibration mode (**SETUP|CALIBRATE|CALIBRATE TPL|MULTIPLE MEASUREMENTS**) to confirm the setting and once the temperature sensor reading is stable the appropriate gain has been established.

COMMUNICATIONS PROTOCOLS

The UMSA are triggered by sending a signal from the computer. All communications are at 9600 baud 8 data bits, 2 stop bits no parity. The following are the signal commands:

"M" - Measure

Instructs UMS to return 30 measurements. This is used for setting the TPL up and debugging. The UMS returns 64 bytes of data. The first 2 bytes returned are 00H. The third byte is the LSB byte of the distance measurement for the first nodes first sensor (from passenger side). The fourth byte is the MSB byte of the distance measurement for the first nodes first sensor. The next 58 bytes contain the same data for the next 29 sensors across the TPL. After the data a 2 byte checksum is sent which is the sum of the entire data set (first 62 bytes).

These 2 bytes are converted to a 16 bit binary number. The sensor measurements are converted to the distance to the ground from the ultrasonic transducer face using a factor of 0.0429768 mm/count or 0.001692 inches/count.

"C" - Chainage

Instructs UMS to take and store 30 measurements and return an "ACK" character if all is well. If there is a problem with a measurement, UMS will return an "NAK". The "C" command is followed by the 2 byte chainage LSB first. This 2 byte string will be stored in flash memory along with the 30 data sets (60 bytes).

"R" - Reset

Instructs UMS to reset a data pointer to the beginning of the stored data in preparation for downloading data.

© 2001 Data Collection Ltd.

"D" - Download

Instructs UMS to download 64 bytes of data and increment data pointer. The data structure is identical to the "M" command above.

"N" - Node Address Set

A 2 byte command that allows setting the node number of a UMS module. The first byte is the "N" character and the second byte is a binary number from 1 to 6 that sets the node address of one of the ultrasonic modules. If this command is received by a module and its node set push button is depressed, the module will take the node number as its own. The master controller returns an "ACK" if any node takes this address. The master returns a 01H if there is no response from the nodes.

© 2001 Data Collection Ltd.

ANNEX H INSTALLING THE ROMDAS VIDEO SYSTEM

The ROMDAS Video System (VS) is comprised of the following components:

- video camera in environmentally protected housing;
- character overlay device and cables;
- video recorder with integrated colour monitor;
- necessary cables and connections.

There are two releases of the video system: Version 1 and Version 2. The installation of each is described separately. They both use the same overlay device and this is described at the end of the Annex.

With both systems the first step is to mount the video camera in the vehicle. The camera comes in an environmentally protected housing. This makes it practical to install the camera either inside or outside of the vehicle. It is recommended that the camera be tested in a number of different positions so as to establish the most appropriate location.

The overlay device and VCR **must** both be mounted inside the vehicle. It is recommended that these be mounted on top of each other and placed in a position where they can be readily observed by the operator.

Having installed the hardware, it is necessary to set up the ROMDAS software and overlay device. The software is set up using the **SETUP|OPTIONS|VIDEO SURVEYS** option. This can only be accessed via a password which is available only to those who have purchased the ROMDAS Video System. This option initialises the video system and establishes the location on the screen where the data are overlaid.

VERSION 2 VIDEO SYSTEM SETUP

The v 2 Video System released in 1999 uses:

- Sony camera
- Sony portable VCR

The user should read the manuals for both the products before using the system. The camera should have been preset before shipping. This sees the 'DEMO Mode' option turned off. This is a feature which sees the camera demonstrating its features instead of just showing the correct picture. The manual describes the setup, extracts are given below.

The second feature is shutter speed. It is recommended in the Sony manual that the speed be in the range of 1/300 to 1/425. You should test the system to confirm the most appropriate shutter speed given your operating conditions.

Figure H.1 shows the connections and setup for the v 2 video system. The camera and 12 v adapter are installed inside a protective enclosure which is mounted on the outside of the vehicle. The enclosure has an optical quality lens and is sealed against the elements. There are three cables coming from the enclosure:

- 12 v power
- S-Video cable
- Remote control cable

These enter the protective enclosure via two environmentally protected sockets on the base of the enclosure.

© 2001 Data Collection Ltd.

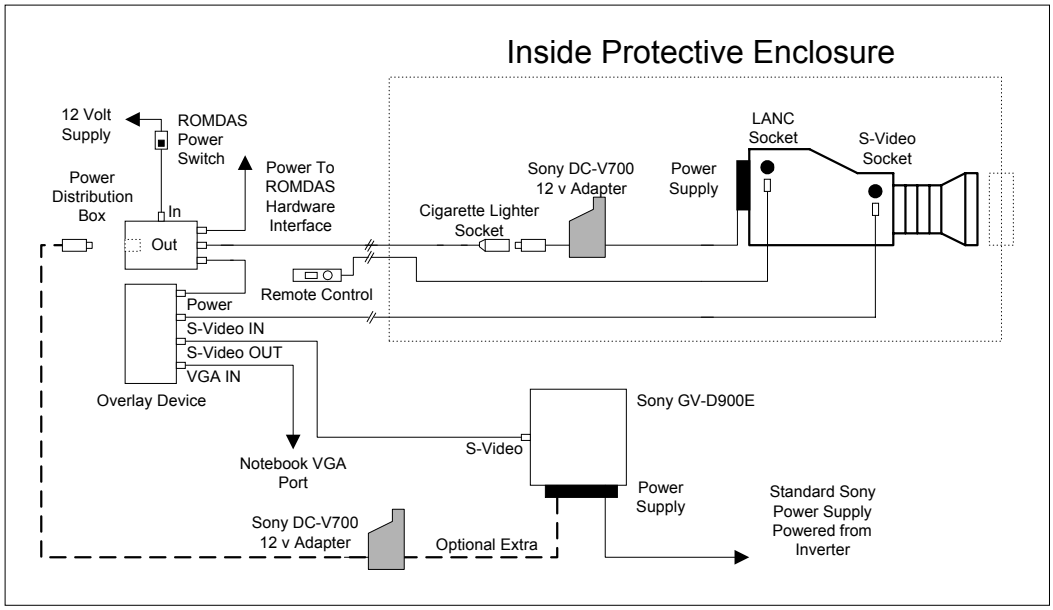


Figure H.1: ROMDAS Version 2 Video System

The connections are as follows:

- Connect the ROMDAS power distribution box to a 12 v supply.
- Connect the plug on the ROMDAS power switch to the power distribution box IN socket. This supplies power to the video system.
- Connect a plug from the power distribution box power output socket to the ROMDAS hardware interface.
- Connect the camera power plug to an output socket on the power distribution box.
- Connect the overlay device power plug to a socket on the power distribution box. This cable has a WHITE collar on the end which connects to the overlay device.
- Connect the S-Video cable from the protective enclosure to the S-Video IN socket on the overlay device.
- Connect an S-Video cable from the overlay device S-Video OUT to the VCR S-Video socket.
- Connect the overlay device cable from the VGA IN port to the notebook external VGA port.

There are two options for powering the VCR. If an additional DC-V700 adapter has been purchased you can run it from another 12 v source or from the cigarette lighter on the power distribution box. However, the standard practice is to run it from the inverter which also powers the notebook computer.

The protective enclosure is illustrated in Figure H.2 without the camera installed. The enclosure has foam inserts which keep the camera in place. The 12 v adapter is attached to the rear of the enclosure with industrial strength Velcro fasteners. As mentioned earlier, the cables come up through the two grommets on the base of the enclosure.

Figure H.3 shows the enclosure with the camera in place. Before the camera is inserted in the box the S-Video and remote cables must be connected and **CLEAN THE INSIDE OF THE GLASS**. The remote cable goes into the 2.5 mm socket labelled 'LANC Connection'. The camera is then inserted carefully into the box until it is firm against the far side. It should be moved forward so that it is 2-3 mm from the rear of the protective lens. Once positioned, the additional foam insert should be placed at the top of the camera to hold it in position. **DO NOT FORCE THE FOAM IN**. Each case is custom manufactured for the camera and the fit should be tight, but not overly so.

© 2001 Data Collection Ltd.

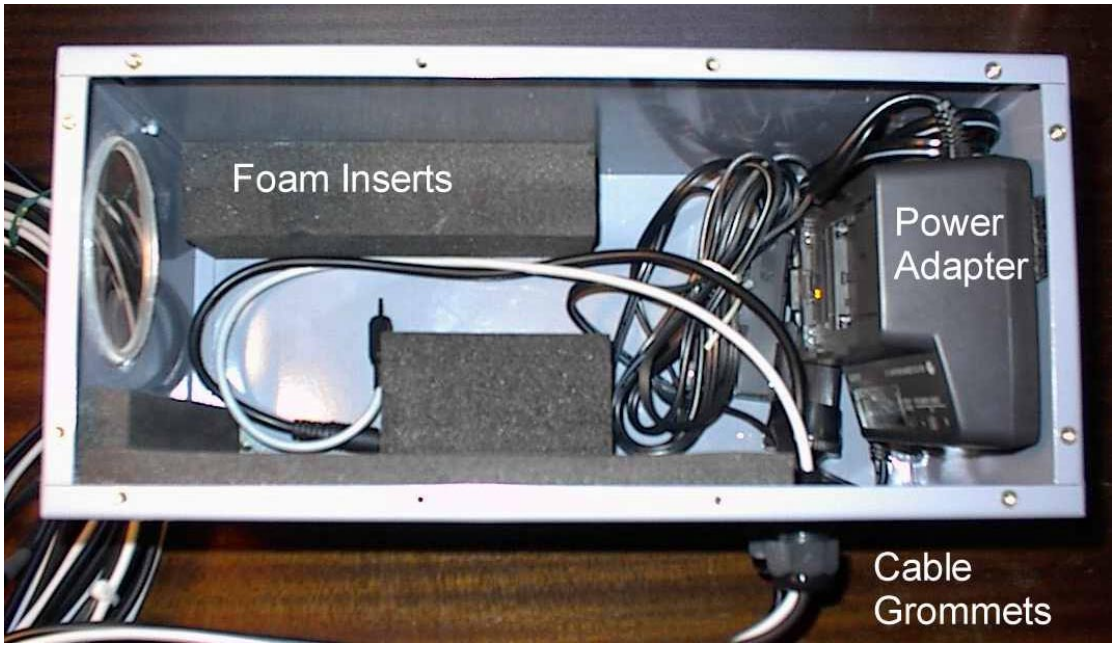


Figure H.2: Protective Enclosure Without Camera

Figure H.3: Enclosure With Camera In Place

The camera should be turned on via its power switch. If the remote control is connected to the extension cable there should be no power until the switch is turned on.

Once the camera is properly positioned, it should be tested to ensure that the shutter speed and focus are correct (see the camera's manual). Once this is done, the camera should be sealed in the unit by putting silicon sealant around the rim of the lid and fastening it closed. The grommets on the bottom should also be inspected to ensure that they are sealed.

The camera should be inspected regularly to ensure that the watertight seal is being maintained. Particular care should be taken to inspect the lens sealing.

© 2001 Data Collection Ltd.

See the end of this annex for operating the overlay device. The following are specific notes for setting up the individual cameras.

SONY TRV-120E	
Date or time showing on video (pg 71, 94, 101 and 102)	Turn this off using the menu setting
Steady Shot (pg 88 and 89)	The Steady Shot should be turned ON to compensate for camera-shake.
Manual Focus (pg 58 and 59)	It is recommended that the camera be set to manual focus either on the road at a fixed distance in front of the vehicle or to infinity. You do this by setting the Focus button to manual and turning the focus dial on the front of the camera. If using autofocus, ensure that the image is set on INFINITEY. This will see the following image displayed:
Shutter Speed (pg 57)	You cannot control the shutter speed on this camera. It is recommended that the Auto Exposure function be set to 'Sports lesson mode' since this minimises shake on fast-moving subjects. When this is done the camera will show this image:

SONY TRV-110E	
Date or time showing on video (pg 35 and 79)	Turn this off using the menu setting
Steady Shot (pg 80)	The Steady Shot should be turned ON to compensate for camera-shake.
Manual Focus (pg 58)	It is recommended that the camera be set to manual focus either on the road at a fixed distance in front of the vehicle or to infinity. You do this by setting the Focus button to manual and turning the focus dial on the front of the camera. If using autofocus, ensure that the image is set on INFINITEY. This will see the following image displayed:

© 2001 Data Collection Ltd.

Shutter Speed (pg 54)	You cannot control the shutter speed on this camera. It is recommended that the Auto Exposure function be set to 'Sports lesson mode' since this minimises shake on fast-moving subjects. When this is done the camera will show this image:

SONY TR-3400E	
Date or time showing on video (pg 35)	Turn this off by pressing the Date and/or Time buttons on the side of the camera.
Steady Shot (pg 59)	The Steady Shot should be turned ON to compensate for camera-shake.
Manual Focus (pg 62)	Under some circumstances you may like to set the focus to manual and focus either on the road at a fixed distance in front of the vehicle or to infinity. You do this by setting the Focus button to manual and turning the focus dial on the front of the camera.
Shutter Speed (pg 66)	The shutter speed should usually be set to around 1/300. If the power is completely disconnected from the camera the shutter speed will need to be reset.

VERSION 1 VIDEO SYSTEM SETUP

Figure H.4 illustrates the Version 1 ROMDAS Video System.

The v 1 Video System comprised:

- Custom camera
- Sony GVS-50E 8 mm VCR

The video system comes with a remote control unit. This has six buttons:

- **Auto Focus**. This enables the automatic focusing facility of the camera. It is recommended that this usually be turned **off** and that the camera be manually focused. This will ensure that the camera is focused on the points of interest.
- **Back Light**. This image enhancement should be turned **off**.
- **Zoom In/Zoom Out**. This controls the zoom of the camera. The camera should be adjusted to a suitable image size. The standard camera will record two lanes of traffic. For a wider zoom a special attachment is available.
- **Focus In/Focus Out**. This controls the focus of the camera.

© 2001 Data Collection Ltd.

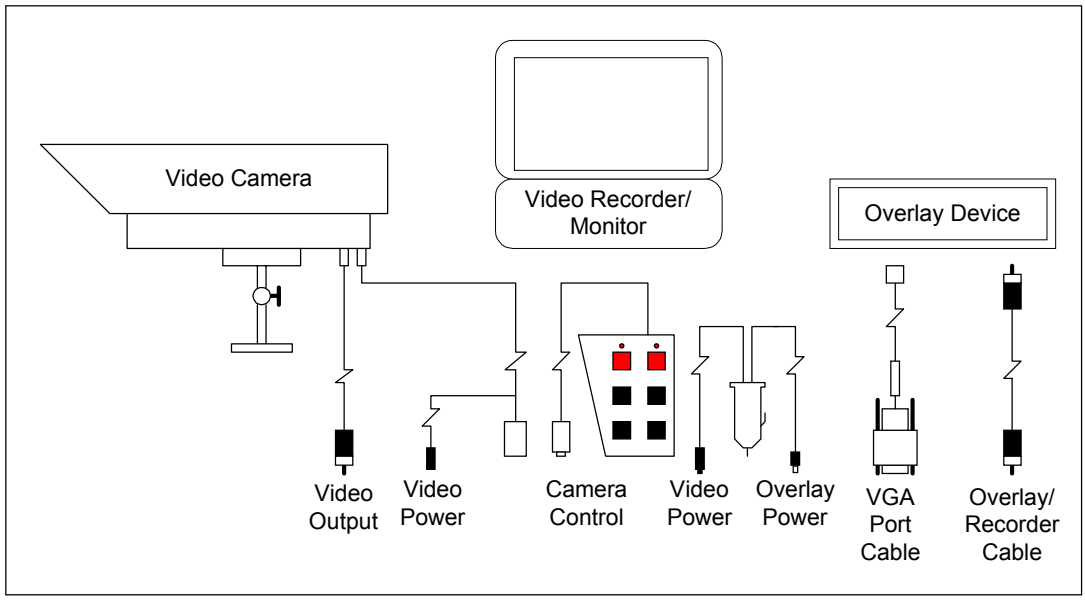


Figure H.4: ROMDAS Version 1 Video System

The following are the connections which must be made:

- the video output from the camera is connected to the overlay device composite video input;
- the camera control unit is connected to the camera control plug on the video camera. The camera control plug is metal with 6 pins;
- the camera power is supplied via a three plug socket from the cigarette lighter adapter;
- the overlay device composite video output is connected to the recorder video input;
- the overlay device power is supplied via the two prong socket from the cigarette lighter adapter;
- the VGA port cable is connected to the notebook computer external display port.

The power for the video recorder will come from either the optional DC power adapter or alternatively by connecting the standard AC adapter to a power inverter connected to the vehicle cigarette lighter or battery.

OVERLAY DEVICE

The manual from the overlay device should be reviewed to familiarise yourself with its operation prior to using it.

Once the overlay device has been connected to the camera, VCR and the computer as described above, it is ready to use. There are two versions of the overlay device, and the instructions for each are given below.

Coriogen Ellipse (2001 Onwards)

The CORIOgen unit has several advantages over the previous VinGen units.

The CORIOgen supports both the PAL and NTSC video standards. It has a On Screen Display (OSD) for setting menu items with buttons on the front panel as well as the remote control. It also offers improved image control and resolution.

© 2001 Data Collection Ltd.

The CORIOgen connects to the ROMDAS system in the same way as the older VineGen.

The first time the system is used you will need to set up the following options which then are saved. The unit can then be usually used without any further adjustments. Select the following items from the sub-menus:

Overlay Menu:
- Signal Type – selecting the video input. Select CVid or SVid (Composite or S-Video) with ROMDAS you will generally using the S-Video signal type.
- Mode Set to Overlay

Advanced Menu:
- Video Standard – PAL or NTSC. Select PAL or NTSC depending upon the standard for the camera used.

After these are set you should run the AutoSet function so that the unit knows the size of the incoming computer image. You can then use arrow keys to fine tune the horizontal and vertical size as well as the position.

Save all settings by using the STORE button on the remote control or holding down MENU and FREEZE on the front panel for about two seconds (both confirmed by high pitch beep). These settings will now set whenever the unit is turned on.

VineGen II and VineGen Pro (Pre-2001)

Press the **OVERLAY** button on the remote control. At this point the video image will be overlaid on the screen.

To refine the settings, start the ROMDAS roughness survey with the reduced screen option set to Y. This will see the standard screen replaced by a blank screen with 5 lines of data on a blue background. The video screen will show the image from the camera and the data from the ROMDAS survey.

It may be necessary to perform the following adjustments to improve the clarity of the image:

- The overlaid text may not be at the top of the display. To reposition it press the A/B button and the 'Position' arrow keys to locate the image at the appropriate location.
- The screen can be resized using the "Size" and "Position" controls.
- If the text is too blurred or too skeletal use the "KEY LEVEL" + and - keys to adjust the picture of the text. These buttons change the level of the colours cut out from the overlay. Using the - key will bring back the darker areas and the + key will cut them out.
- The "FILTER" button on the remote switches between two filters. One is high resolution with flicker and the other is low resolution with no flicker.
- The "FREEZE" button will freeze the display image. To unfreeze the image press the button again. This option should not be used with ROMDAS.
- The "FADE" button will fade the computer image in and out. When pressed once the light on the "FADE" light on the MultiGen2 will come on and the computer image will fade out. To fade in again just press the "FADE" button again. To change the length of this fading period use the "FADE TIME" + and - keys. This option should not be used with ROMDAS.

© 2001 Data Collection Ltd.

© 2001 Data Collection Ltd.

ANNEX I FABRICATING A PROXIMITY SENSOR

A proximity sensor is a useful accessory for calibrating a roughness meter or the ROMDAS Transverse Profile Logger. The ROMDAS software will start and stop the calibration upon receiving pulses from the sensor. This ensures that the calibrations start and stop at exactly the same location every time, irrespective of vehicle speed. A proximity switch therefore requires a start and stop target in order to be triggered[1].

There are two types of proximity sensors which can be used: electronic or mechanical. Electronic sensors use pulses, such as ultrasonic or infrared, to establish the presence of an object. Mechanical sensors require physical contact with an object to be triggered.

During the development of the ROMDAS proximity sensor option the use of electronic sensors was investigated. It was found that while these worked adequately in a laboratory setting, they were not well suited to actual field applications. This was primarily due to the response time required for a signal to register: at high speeds a very large target was required and even then missed signals were frequent. Accordingly, the development focused on a simple mechanical sensor using easy to obtain parts.

The sensor developed is illustrated in Figure I.1. It consists of the following:

- **1 x hasp**. This is a common hardware item which is used with a 'staple' and a padlock to lock doors/gates;
- **1 x magnetic alarm sensor**. These sensors are used on doors and windows as part of a burglar alarm system. When the sensors are within $\pm$ 5 mm the circuit between the two terminals is complete, when apart it is broken;
- **1 x 1 m long hollow rod**. This is a light weight metal rod, such as can be used for curtains. It extends out to the kerb side of the vehicle.
- **2 x rod holders.** These are used to attach the rod to the hasp.
- **1 x spring**. This must be strong enough to keep the magnetic sensors in contact with each other.
- **screws/bolts.** The necessary nuts and bolts to connect the hasp to the vehicle and rod holders to the hasp; screws to connect the rod to the holders.

The mechanical sensor is attached on the kerb side of the vehicle to the back of the bumper or ROMDAS Transverse Profile Logger (TPL). If there is insufficient clearance on the back of the bumper to attach the device, an additional metal plate should be affixed to the front of the vehicle with sufficient overhang to mount the sensor on.

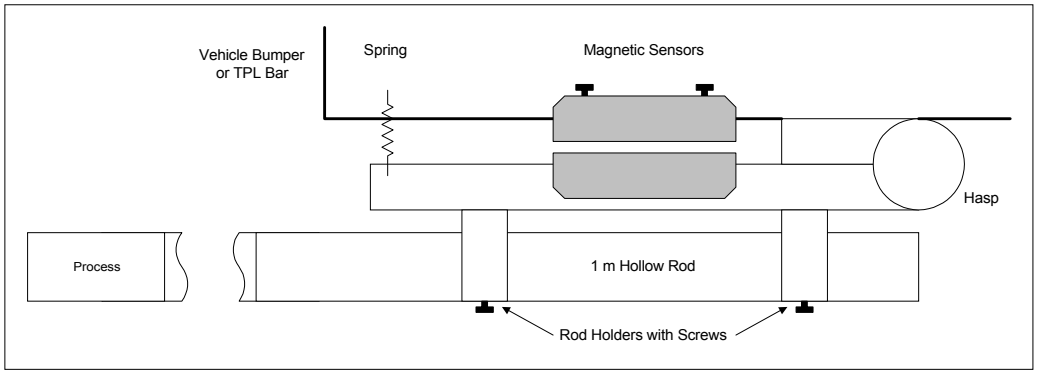


Figure I.1: Mechanical Proximity Sensor

[1] When using a proximity sensor with ROMDAS it is possible to have it only trigger the start of a survey and manually end the survey.

© 2001 Data Collection Ltd.

The sensor is triggered by having a pole or heavy stand adjacent to the start of the test section. When the vehicle is driven along the road the rod strikes this pole which causes the magnetic sensor circuit to be broken. The ROMDAS system then starts recording data. The spring brings the bar back into its original position. At the end of the section another pole is struck and the circuit is again broken. The causes ROMDAS to halt recording.

The wiring of the circuit is as shown in Figure I.2. There are three points to note:

- the sensor is connected to the ROMDAS hardware interface reverse switch sensor. The software looks for a change in state of the reverse switch during the survey as the trigger to start recording.
- The positive signal is routed through the magnetic switch. This goes to the **centre pin** on the reverse switch bayonet plug. The outer pin is the earth line.
- It should be noted that the magnetic sensor with the wiring connections is affixed to the vehicle mounted part of the sensor, not the part with the rod.

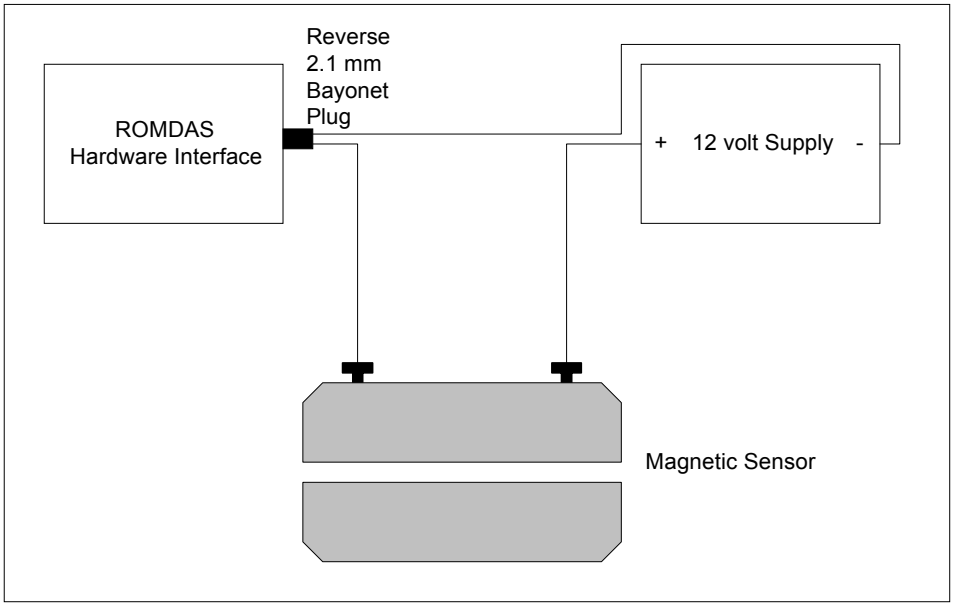


Figure I.2: Proximity Sensor Wiring Circuit

NOTE: When conducting the calibration survey with the above switch it is essential that care be taken not to come into contact with pedestrians or any other roadside features.

© 2001 Data Collection Ltd.

ANNEX J CALIBRATING A ROAD ROUGHNESS METER TO IRI

INTRODUCTION

As described in Chapter 4, each vehicle responds differently to roughness due to variations in the springs, dampers and tyres. It is therefore essential to calibrate each roughness survey vehicle against a standard roughness so that its measurements can be related back to the standard roughness. This annex describes the method which should be followed to calibrate roughness meters to the International Roughness Index (IRI). It is based on the work presented in Sayers, et al. (1986) and Sayers (1995)[1]. It is recommended that these references be reviewed in addition to the material presented here. Sayers (1995) is particularly worthwhile for the additional background material to the development of the IRI and other considerations in determining IRI.

THE INTERNATIONAL ROUGHNESS INDEX

Sayers (1995) gives the following definition for the IRI:

1. IRI is computed from a single longitudinal profile. The sample interval should be no larger than 300 mm for accurate calculations. The required resolution depends on the roughness level, with finer resolution being needed for smooth roads. A resolution of 0.5 mm is suitable for all conditions.
2. The profile is assumed to have a constant slope between sampled elevation points.
3. The profile is smoothed with a moving average whose baselength is 250 mm.
4. The smoothed profile is filtered using a quarter-car simulation, with specific parameter values (Golden Car), at a simulated speed of 80 km/h.
5. The simulated suspension motion is linearly accumulated and divided by the length of the profile to yield IRI. Thus, IRI has units of slope (usually m/km).

The underlying IRI model is a series of differential equations which relate the motions of a simulated quarter-car to the road profile. Figure J.1 illustrates the quarter-car model used and the parameters adopted (Sayers, 1995).

The IRI is the accumulation of the motion between the sprung and unsprung masses in the quarter-car model, normalised by the length of the profile. Mathematically this is expressed as:

$$IRI = \frac{1}{L}\int_0^{L/V} \left| \dot{z}_s - \dot{z}_u \right| dt$$

where IRI is the roughness in IRI m/km
L is the length of the profile in km
V is the simulated speed (80 km/h)
$\dot{z}_s$ is the time derivative of the height of the sprung mass
$\dot{z}_u$ is the time derivative of the height of the unsprung mass

[1] Sayers, M.W., Gillespie, T.D. and Paterson, W.D.O. (1986). *Guidelines for the Conduct and Calibration of Road Roughness Measurements.* World Bank Technical Paper No. 46, The World Bank, Washington, D.C.
Sayers, M.W. (1995). *On the Calculation of IRI from Longitudinal Road Profile.* TRB Paper No. 950842, Transportation Research Board, Washington, D.C.

© 2001 Data Collection Ltd.

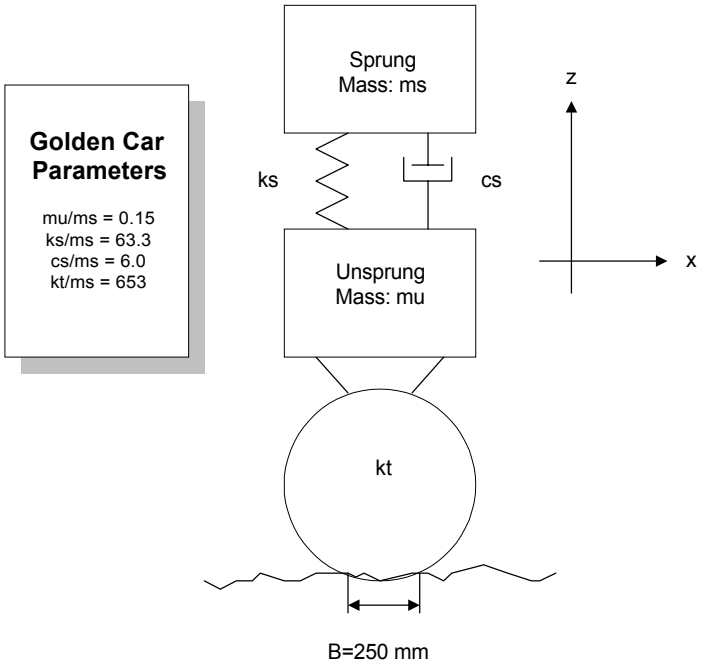


Figure J.1: IRI Quarter-car Model

The algorithm used to calculate the IRI is described in Sayers, et. al. (1986) and elaborated on in Sayers (1995). Both references provide a computer listing for calculating the IRI; Sayers, et al. (1986) in BASIC and Sayers (1995) in FORTRAN. An comprehensive analysis program is available on the Internet from the University of Michigan at http://www.umtri.umich.edu.

In order to calculate the IRI the following steps must be taken:

- identify calibration test sections;
- determine the elevation profile **of each wheelpath** for each test section;
- using the profile data, run a quarter-car simulation for the reference vehicle over each wheelpath and calculate the wheelpath IRI;
- establish the average IRI for both wheelpaths.

SELECTING AND PROFILING CALIBRATION SECTIONS

The objective of calibration section profiling is to obtain an accurate representation of the road profile. It is necessary to identify calibration sections which cover the full range of roughnesses the survey is likely to encounter[1]. These sections should have the following characteristics:

- the sections should be 200-300 m long (400-450 with MERLIN) with adequate geometry before and after the section to ensure that they can be travelled at a constant speed;
- the roughness should be fairly uniform along its length insofar as there are not short sub-sections with high roughnesses interspersed with sub-sections containing lower roughnesses;

[1] This can be done using an uncalibrated roughness meter to differentiate between sections with different roughness levels.

© 2001 Data Collection Ltd.

- the surface should not be broken (i.e. potholes or bad depressions) so that the profiling survey can get the true profile;
- they should have low traffic volumes so that the roughness will not change significantly over time and so that you will survive the calibration survey;
- one should not have combinations of rigid and flexible, or machine laid and hand laid, sections since these can have different roughness properties, although this is not always possible in some countries if one wants to cover the full range of roughnesses;
- the beginning and end of sections should be clearly marked;
- permanently mark the wheelpaths for profiling using nails and painting them white. During recalibration you can then readily remark the wheelpaths.

The number of test sections required is calculated by dividing 4500 by the site length in m, with a minimum of 8 (Sayers, et al., 1986). For example, with 300 m test sections 15 sites would be required.

The sections should be profiled at maximum intervals of 300 mm using one of the techniques below:

- TRL MERLIN;
- TRL Beam;
- A rod-and-level survey[1];
- DIPSTICK;
- Profilometer.

Irrespective of what method is used, the device should be calibrated before the survey. Each instrument will have its own procedures for calibration and these should be carefully followed.
The following sections will discuss the use of ROMDAS LPCD, MERLIN and the TRL Beam. This is followed by a discussion of calculating IRI from the actual profile data.

MERLIN

As described in[2], the MERLIN (a **M**achine for **E**valuating **R**oughness using **L**ow-cost **IN**strumentation) was devised to measure the roughness of a calibration inexpensively, quickly, easily and reliably.

MERLIN consists of a rigid metal frame, 1.8 m long, with a wheel at the front, a curved foot at the rear and a moveable probe midway between the two which rests on the road surface. If the road were always smooth, the probe would always lie on a straight line between the bottom of the wheel and the rear foot. If the road were uneven, the probe would usually be displaced above or below the line.

To measure the displacements, the probe is attached to a pivoted arm, at the other end of which is a pointer which moves over a chart. The arm is pivoted close to the probe so that a movement of the probe of 1 mm will produce a pointer movement of 1 cm.

The roughness of a section of road is measured by wheeling the MERLIN along the road with the handles raised. Once every wheel revolution, the handles are lowered so that the

---

1 For a description on using a rod-and-level survey for profiling test sections see:
Visser, A.T. (1982). *A correlation study of roughness measurements with an index obtained from a road profile measured with rod and level.* Technical Report RS/2/82. National Institute for Transport and Road Research, CSIR, Pretoria.

2 *TRL Overseas Newsletter*, February 1993 - No. 10. Transport Research Laboratory, Crowthorne.
Cundill, M.A. (1991). *The MERLIN Low-Cost Road Roughness Measuring Machine*. TRRL Report 301, Transport Research Laboratory, Crowthorne.

© 2001 Data Collection Ltd.

probe and rear foot touch the ground and the resulting pointer position is recorded as a cross on a chart. Two hundred measurements are made to produce a histogram. The width of the central 90 per cent of the histogram is measured form the chart and this can be converted directly into roughness.

Although the MERLIN is manufactured to rigid specifications, its accuracy is predicated on the exact ratio of 10:1 or 5:1 being maintained. However, with use it is possible for this to be lost. Accordingly, it is necessary to apply a correction factor to the readings. This correction factor is established as follows (Kampsax, 1992)[1]:

MERLIN Survey in Gujarat, India. The wood was the width of the vehicle track and the pavement was painted to precisely locate the wheelpaths

- place the MERLIN on a smooth level surface, such as a terrazzo office floor;
- tape a blank sheet of A4 paper onto the chart holder;
- adjust the probe until the pointer is roughly in the centre of the paper;
- mark the position of the pointer on the paper;
- slide under the probe a steel plate of known thickness (such as the 6 mm plate supplied by FARNELL) - the exact thickness is not important but it must be measured accurately with a micrometer or vernier gauge;
- make a second mark on the paper and measure the distance between the two marks with a ruler;
- repeat several times at different locations on the floor and calculate the average movement of the pointer.

The correction factor for the machine is given by:

$$CF = (10 \times T)/PM$$

[1] Kampsax (1992). *ADB Farm-to-Market Roads Project Phase II, Road Maintenance Management Systems, Volume I - System Concepts and the Database, Appendix H: Roughness Meter Calibration.* Report to the Asian Development Bank

© 2001 Data Collection Ltd.

where CF is the MERLIN correction factor
T is the thickness of the plate in mm
PM is the average movement of the pointer in mm

If you are using the 5:1 setting the 10 in the above equation would be replaced by 5.

For example, if the plate thickness is 6 mm and the average pointer movement is 62 mm the correction factor is 0.97.
The roughness is calculated using the following equation (Cundill, 1991):

$$IRI = 0.593 + 0.0471\ D\ CF$$

where D is the roughness in terms of the Merlin scale in mm

The above equation is based on machine laid surfaces. Recent research in Indonesia has suggested the following equation for hand laid Penetration Macadam surfaces (Cundill, 1995)[1]:

$$IRI = 1.913 + 0.0490\ D$$

The equation was developed from 8 data points over the range of $97 < D < 202$ ($6.7 < IRI < 11.3$) so it must be used with some caution.

In addition to calibrating the probe, it is also necessary to check on the circularity of the front wheel (Kampsax, 1992). As it is difficult to stop in exactly the same position each time, a part of the wheel circumference should be found which is of constant radius. This can be done by keeping the MERLIN so that the rear foot and probe remain in the same location. Then make marks on the paper while turning the wheel in increments of 5 - 10 cm of its circumference. When a section is found that gives constant readings, mark it on the rim with white paint.

TRL BEAM

The TRL Beam is a manual profilometer. It uses a highly precise linear vertical distance transducer to measure the profile and employs standard electronic methods for calibration. The beam is manually moved along the road to record the profiles for the full calibration section. It can also be used for transverse profiles and the photo below shows the TRL beam used for testing the ROMDAS TPL.

The Beam measures the profile of the road at 100 mm intervals with a resolution of better than 0.20 mm. It then calculates the IRI from the elevation profile along with the root mean standard deviation (RMSD) for a baselength of 1.8 m. The latter is used with a regression equation to calculate the standard roughness in terms of the towed TRL 5th wheel bump integrator.

It is also possible to use the TRL Beam to calculate the regression equations between the reference roughness (in IRI or 5th wheel BI) and the vehicle readings. This is done by entering in values from between 3 and 20 test sections.

[1] Correspondence with author.

© 2001 Data Collection Ltd.

TRL Beam Measuring Transverse Profiles

CALCULATING THE IRI FROM PROFILES

When using a rod-and-level survey, the DIPSTICK, or any other profiler output, it is necessary to calculate the IRI from the elevation profile.

The first stage is to reduce the data into the appropriate format. It is recommended that the individual profile data be reviewed graphically so as to ensure that there are no errors in recording or processing. The importance of this is illustrated in Figure J.2 which is from a calibration using the DIPSTICK in Myanmar. During the data entry there were several transcription errors which led to discontinuities in the right wheelpath elevation profile. Had these not been corrected the IRI would have been 26.0 instead of 14.7.

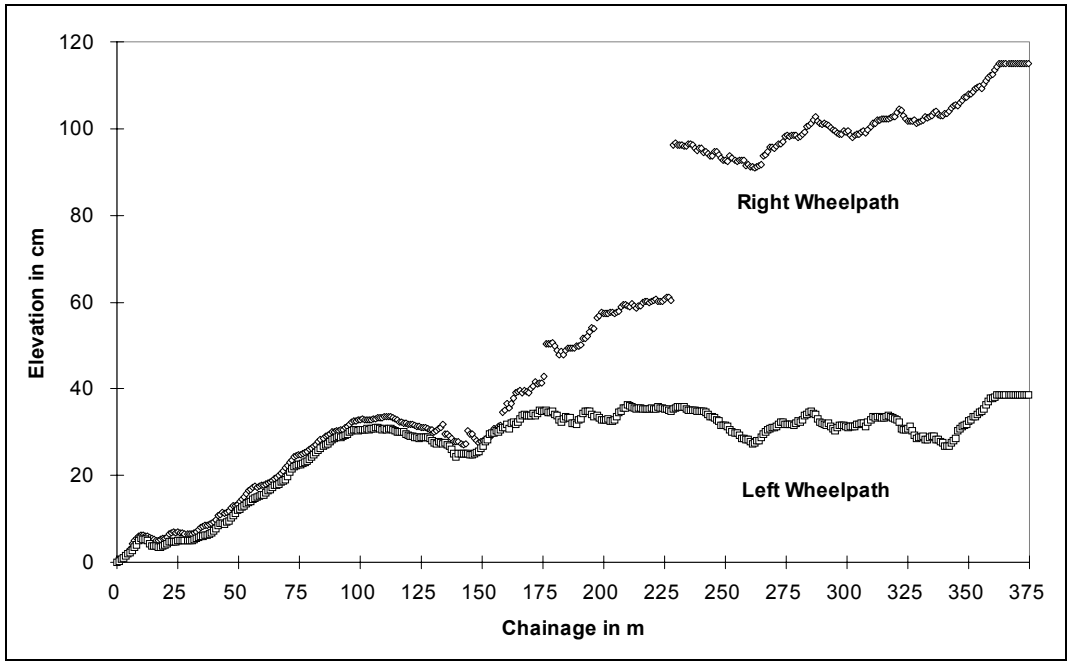


Figure J.2: Example of DIPSTICK Data Problem from Myanmar

© 2001 Data Collection Ltd.

The ROMDAS LPL analysis routine calculates the IRI from elevation profile data. The same routine will work with any elevation profile. The routine is accessed from the **DATA MANAGEMENT|ROUGHNESS|CALCULATE IRI** menu.

The input file contains two fields: CHAINAGE (N 10.2) and ELEVATION (N 10.1). The CHAINAGE is the spacing between elevation measurements (in m) and the ELEVATION is the elevation of each point (in mm).

The software checks the spacings between elevations and then establishes the appropriate IRI coefficients from the file IRICOEFF.DBF. The IRI is then calculated from the elevation profile and displayed on the screen.

The ROMDAS distribution disk contains a BASIC program for calculating the IRI from Sayers, et al. (1986). A FORTRAN program listing is given in Sayers (1995). There is also a FoxPro (xBASE) program. This program is the same as the routine in the ROMDAS data processing software.

As described earlier, the IRI is based on a smoothed profile with a moving average whose baselength is 250 mm. When the profile has been established using a profilometer[1] which contains digital filtering and averaging, the IRI calculation routine should be adjusted to ensure that the data are not averaged a second time (Sayers, 1995).

The elevation profiles for each wheelpath should be analysed separately and the wheelpath IRI should be calculated. Averaging these two values will give the test section IRI.

THE CALIBRATION SURVEY

The calibration survey is conducted by operating the vehicle over each calibration section and recording the roughness meter output. There are a few practical considerations in calibrations and roughness surveys:

- calibrate the odometer;
- ensure that the tyre pressure is at the correct operating pressure[2];
- load the vehicle to the same level that it will be at during the survey (e.g. driver, operator, fuel);
- before starting a major survey install new tyres and dampers a few weeks before the survey so they have time to be run in;
- recalibrate the vehicle at least once a month or every 3000 km.

A sufficient number of calibration runs should be made to ensure statistical significance of the mean. Since we are dealing with small samples ($n \leq 30$), the t Distribution should be used to establish the number of runs to give a desired level of confidence. If the roughness has a Normal Distribution, then small-sample confidence intervals for the mean roughness are obtained by:

[1] Examples of profilometers are the ARAN, the GM Profilometer, the TRL High Speed Road Monitor, and the ARRB Profilometer. Irrespective of which is used, it must be ensured that the profilometer is actually recording the profile of both wheelpaths. Some, which only have a single instrument, are 'half-car' devices, not quarter-car, and as such are unable to measure IRI.

[2] The tyre pressure can be set either warm or cold as long as the same state is used in all calibrations and operations.

© 2001 Data Collection Ltd.

where IRI is the mean roughness in IRI m/km
s is the standard deviation of roughness in IRI m/km
n is the number of runs
t is the critical value for the t Distribution

Hamilton (1990)[1] gives the values in Table J.1 for 90 and 95 per cent confidence intervals using the t Distribution.

Table J.1: Critical t Values

Number of Runs	Critical t Value by Confidence Interval	
	90	95
3	2.920	4.303
4	2.353	3.182
5	2.132	2.776
6	2.015	2.571
7	1.943	2.447
8	1.895	2.365
9	1.860	2.306
10	1.833	2.262

On the basis of the above equation, we can define a new statistic as:

$$\beta = t\frac{s}{\sqrt{n}}$$

The results are acceptable when β is within a certain percentage of the mean. For most applications we would set a limit of a 10 per cent confidence interval. Thus, the results are acceptable if:

$$\beta \leq 0.10 \text{ IRI}$$

The following is how we would use this theory:

1. Conduct a minimum of 5 runs of the roughness meter and record the roughness of each run.
2. Calculate the mean roughness (BI) and the standard deviation (s).
3. Calculate the statistic β. For example, if there were 5 runs with a mean of 21 and a standard deviation of 0.80 you would calculate it as (95%):

$$\beta = 2.776\frac{0.80}{\sqrt{5}} = 0.99$$

   In the above equation the value of 2.776 is from Table J.1 and corresponds to 5 runs with 95% confidence.
4. Check that β is within 10 per cent of the mean. In the above example β = 0.99 which is less than 2.1 (0.10 * 21) so it would not be necessary to do any additional runs.

[1] Hamilton, L.C. (1990). *Modern Data Analysis - A First Course in Applied Statistics.* Brooks/Cole Publishing Company, Pacific Grove, California.

© 2001 Data Collection Ltd.

One should always watch for outliers and delete them from the analysis. An example of this from Myanmar is given below in Table J.2. In this study the outliers were rejected based on 'judgement' and these are highlighted in the table. This is not an advisable approach and statistically based technique should be used such as those described in Hamilton (1990).

Table J.2: Example of Deleting Outliers from Calibration Runs

Site	Profiled IRI	Speed (km/h)	Roughness Measurement by Run Number									Mean Rough.	Std. Dev.	Load
			1	2	3	4	5	6	7	8	9			
1	2.35	50	20	22	20	22	21	22	20	21	21	21.0	0.82	Standard
		50	23	22	21	22	22	22	21	21	22	21.6	0.48	Extra
2	5.72	50	49	48	50	50	50	49	49	50	48	49.2	0.79	Standard
		50	49	50	51	51	50	50	50	49	50	50.0	0.67	Extra
3	7.77	50	71	70	74	76	70	72	71	73	78	72.1	1.85	Standard
		50	75	73	76	80	74	75	76	73	74	74.5	1.12	Extra
4	11.29	50	121	120	120	121	120	120	121	121	117	120.5	0.50	Standard
		50	120	119	119	118	119	120	120	119	119	119.2	0.63	Extra
5	12.16	50	146	146	147	146	146	147	147	146	147	146.4	0.50	Standard
		50	143	144	143	143	144	144	143	143	143	143.3	0.47	Extra
6	8.45	50	90	89	89	93	88	90	90	89	90	89.4	0.70	Standard
		50	86	89	93	87	89	88	87	87	88	87.6	0.99	Extra
7	8.08	50	72	72	71	72	71	72	71	72	72	71.7	0.47	Standard
		50	73	73	74	73	73	74	74	73	74	73.4	0.50	Extra
8	3.38	50	37	37	36	37	37	36				36.7	0.47	Standard
		50	37	37	37	37	36	37				36.8	0.37	Extra

NOTES: 1/ The highlighted cells are readings rejected in the analysis as outliers.

The Myanmar results are notable since they show the high repeatability that can be obtained - all the results have confidence intervals at 95 per cent within 3 per cent of the mean, many less than 1 per cent.

The response of a vehicle to roughness is a function of speed. Thus, different IRI values will arise at different speeds for the same calibration section. Since it is practically impossible to conduct a roughness survey at a constant speed, it is recommended that calibration be done at a range of speeds. This is done by repeating the calibration survey with the vehicle operating at different speeds.

Each measurement run should be started well in advance of the start of the test section in order to bring the vehicle up to a steady state speed before reaching the mark. At the start of the test section the ROMDAS recording is started and it is halted at the end of the section.

ROUGHNESS EQUATIONS

As described in Chapter 5, ROMDAS converts the raw roughness meter counts to the calibrated roughness (i.e. the IRI) using a general equation of the following form:

$$CALIB\_RGH = A0 + A1 * RAW^{A2} + A3 * RAW^{A4} + A5 * \exp(A6\ RAW)$$

© 2001 Data Collection Ltd.

where	CALIB_RGH	is the calibrated roughness in IRI m/km
	RAW	is the raw roughness meter counts in counts/km
	A0 to A6	are regression coefficients

The above formulation has been designed for the maximum flexibility. Not all coefficients will be used in a model as it is typical to have simple linear or polynomial functions.

There is no limit to the number of equations that can be used with ROMDAS. Each equation will be used for all speeds below the mean of the previous and following speeds. For example, if equations were supplied for 50 and 100 km/h the first equation would be used for speeds below 75 km/h and the second for speeds above 75 km/h.

The values of the coefficients A0 to A6 are determined by performing a regression analysis on a set of data values consisting of paired values of the profiled roughness and the raw roughness counts. To facilitate the analysis, the ROMDAS distribution disk contains a non-linear regression program[1]. During the installation of the software, this program is installed into the directory NLREGxx where xx is the current version number of the software.

You must be careful to ensure that all the coefficients are statistically significant in the calibration equation (i.e. the Prob(t) < 0.05) and that there is an acceptable standard error. Please refer to any standard statistical text book or the NLREG manual for a discussion of statistical significance.

An example data set for calibrating a roughness meter, called PAKISTAN.DAT, is provided with the package[2]. The first column of this data set contain values for the IRI (calculated using a MERLIN) and the second a set of raw Bump Integrator counts. Figure J.3 is a plot of these data.

There are eight NLREG files provided which will fit typical equations to the data:

Example Equation	Format of Equation
A	CALIB_RGH = A0 + A1 * RAW
B	CALIB_RGH = A0 + A1 * RAW ^ A2
C	CALIB_RGH = A0 + A1 * RAW ^ 2 + A3 * RAW
D	CALIB_RGH = A0 + A1 * RAW ^ A2 + A3 * RAW
E	CALIB_RGH = A0 + A1 * RAW + A5 exp (A6 * RAW)
F	CALIB_RGH = A0 + A1 * RAW ^ A2 + A5 exp (A6 * RAW)
G	CALIB_RGH = A0 + A5 * exp (A6 * RAW)
H	CALIB_RGH = A5 * exp (A6 * RAW)

The regression analysis files are called ROMDASA.NLR to ROMDASH.NLR. The regression output for each of these files is called ROMDASA.LST to ROMDASH.LST. To perform an analysis you type:

[1] The program supplied is called NLREG and it is distributed with the permission of its author. NLREG is an extremely powerful yet easy to use regression package which runs under MS-DOS. It is distributed as Shareware so should you choose to continue using the program you are expected to register it with the author. Details of the current registration fee is supplied in the file REGISTER.DOC which is found in the subdirectory with the program. The terms of usage are given in the file READ.ME which is in the same subdirectory.

[2] The data are from an actual calibration of a Bump Integrator in Pakistan and were provided by Mr. M.J. Riley of the Riley Partnership in the U.K. His contributions to this annex and the development of ROMDAS are gratefully acknowledged.

© 2001 Data Collection Ltd.

NLREG *filename*

Where the *filename* is one of the analysis files (ROMDASA to ROMDASH). Please note that the analysis files are set up to use the sample data set PAKISTAN.DAT. It will be necessary to replace this with the file of your own data.

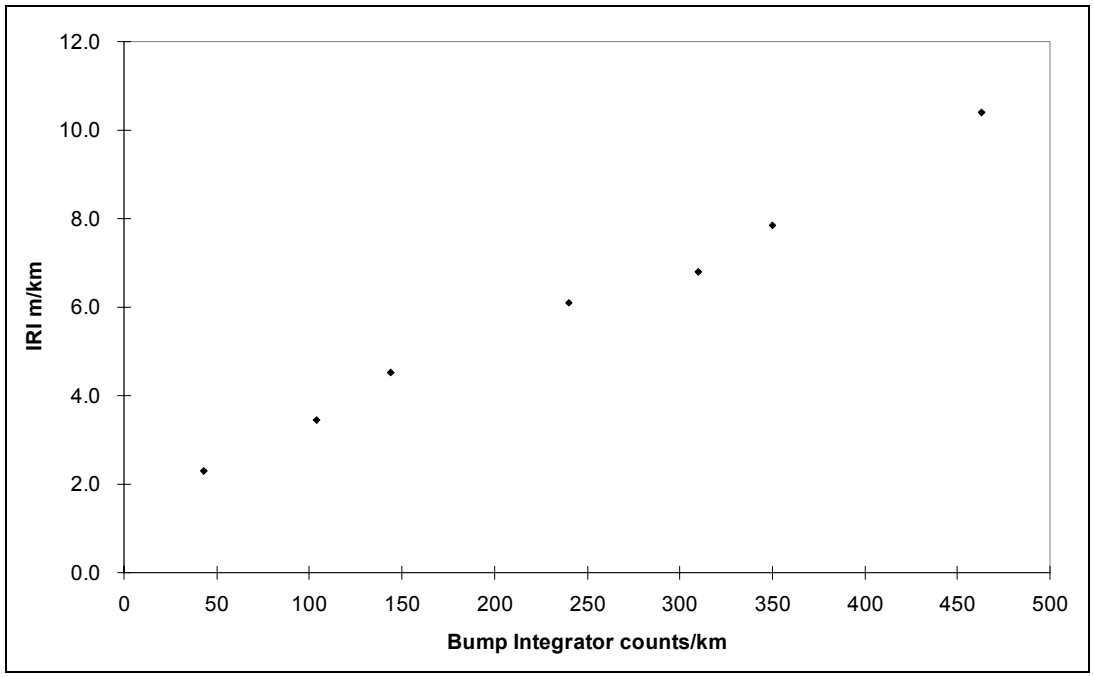


Figure J.3: Bump Integrator Calibration Using MERLIN from Pakistan

To facilitate the analysis, a batch file called ROMDAS.BAT is provided. This will fit each of the 8 equations and combine the output into a single file called ROMDAS.LST. For each equation, a plot is made of the fit of the regression and also of the residuals.

If you run ROMDAS.BAT with the sample data set you will get the results presented in Table J.2.

It proved possible to fit 7 of the 8 equations to the data. However, of these 7 equations, five of them had regression coefficients which were not statistically significant at 95% confidence. Thus, there are only two equations which have statistically significant results:

CALIB_RGH = 1.56 + 0.018 RAW

CALIB_RGH = 2.72 exp(0.0029 RAW)

The standard error of the linear equation is much smaller than that of the exponential and the plot of the predicted versus observed values, and the residual plot, show that it is a much better predictor. It was therefore adopted for use in Pakistan.

© 2001 Data Collection Ltd.

Table J.2: Regression Results Using Pakistan Calibration Data

Equation	R^2	Standard Error	Value	Regression Results by Coefficient					
				A0	A1	A2	A3	A5	A6
A	0.99	0.30	Coeff.	1.56	0.018				
			t	(6.88)	(22.23)				
B	0.99	0.33	Coeff.	1.84	0.010	1.09			
			t	(3.43)	(0.90)	(6.22)			
C	0.99	0.31	Coeff.	1.80	5.61E-6	0.016			
			t	(4.73)	(0.80)	4.36			
D			Coeff.	Did not converge to solution					
			t						
E	0.99	0.30	Coeff.	1.73	0.17			7.7E-12	0.05
			t	(6.27)	(11.40)			(0.00)	(0.02)
F	1.00	0.28	Coeff.	0.58	0.13	0.67		8.3E-4	0.016
			t	(0.26)	(0.32)	(1.29)		(0.04)	(0.34)
G	0.99	0.31	Coeff.	-21.68				23.49	6.6E-4
			t	-0.69				0.76	0.89
H	0.97	0.50	Coeff.					2.72	2.9E-3
			t					(11.49)	(12.32)

NOTES: 1/ The highlighted cells have 't' statistics which indicate that the regression coefficients are not significant at 95 % confidence.

2/ Equation D did not converge to a solution in spite of several attempts with different starting points (see the NLREG manual NLREG.DOC for a description of convergence problems). This is not a viable equation for the data.

A Final Word

If you develop a roughness equation, it should have positive predictions over the full range of roughnesses. This is because even on very smooth roads dynamic effects will lead to some positive readings. Thus, if you have an equation with negative predictions, review your results very carefully!

LOW SPEED EFFECTS

The roughness is a function of speed which is why the roughness calibration coefficients can be specified for different speed ranges. However, a situation may arise where the vehicle is forced to travel at a very slow speed due to the high level of roughness. Under these situations the instrument will not give correct readings under typical calibrations.

Montgomery Watson (2001)[1] found in Tonga that *"… the vehicle could not travel* [at] *the desired survey speed was because the road physically became too rough. The rougher the road the slower the speed of the survey vehicle."* This effect is illustrated in the figures below.

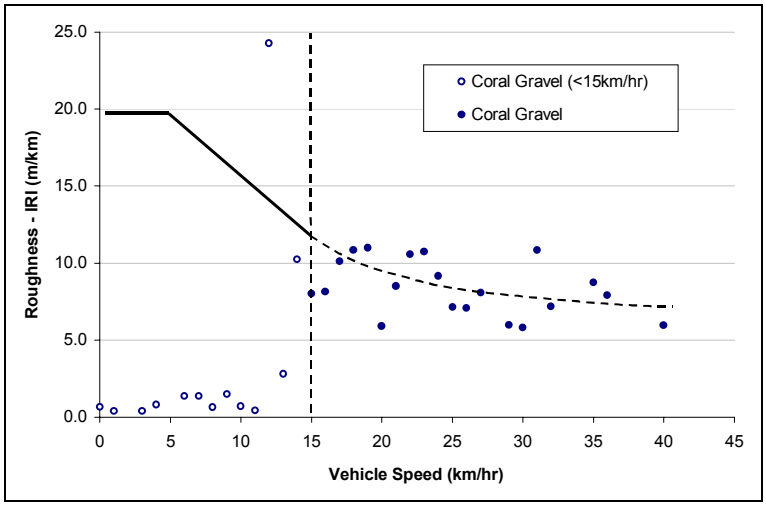
In total, 28% of the unsealed network and 3% of the sealed network had to be driven at speeds below 15km/hr. The following equations were developed to assign an estimated roughness value to these road sections (Montgomery Watson, 2001).

Unsealed

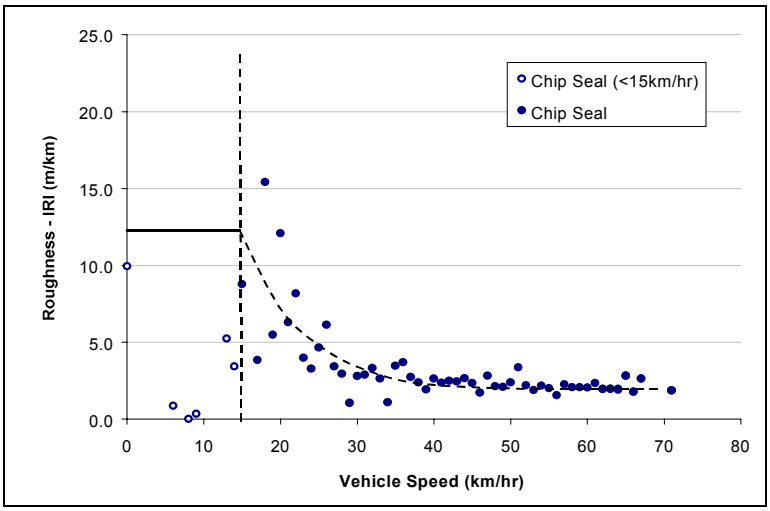
[1] Montgomery Watson (2001). *Tonga Transport Infrastructure Project: HDM-4 Establishment Technical Reference*. Report to the Ministry of Works, Christchurch.

© 2001 Data Collection Ltd.

	IRI = 20	for < 5km/hr
	IRI = 24 – 0.8*Speed	for 5km/hr to 15km/hr
Sealed		
	IRI = 12.5	for < 15km/hr



Effect of Speed on Roughness – Unsealed Roads



Effect of Speed on Roughness – Sealed Roads

The ROMDAS RMS has data processing and QA procedures which will allow for these types of corrections to be applied to ROMDAS survey data.

© 2001 Data Collection Ltd.

ANNEX K TRAVEL TIME AND CONGESTION SURVEYS

INTRODUCTION

Travel time is the total time for a vehicle travel over a section of road. Travel time surveys are conducted to:

- identify problem locations on facilities;
- determine the level of service;
- establish the impact of road improvements;
- as input into economic feasibility studies;
- to evaluate the predictions of, or as input to, transportation planning studies.

It is often coupled with delay – usually defined as the time period when a vehicle is stopped – in order to obtain an overall measure of the performance of a facility.

Congestion surveys are similar to travel time surveys except the objective is to establish the level of traffic interactions. These data are particularly useful in economic feasibility studies, such as those using the forthcoming World Bank HDM-4 Model.

This annex describes conducting travel time and congestion surveys along with the analysis and presentation of the results.

MEASURING TRAVEL TIME

The two common methods for conducting travel time surveys are:

- test runs in a vehicle equipped with an instrument such as ROMDAS;
- licence plate observations.

This annex focuses on the use of the ROMDAS.

Vehicle test runs may be done using different techniques.

Floating Car

The objective of a 'floating car' survey is for the vehicle to travel along the road at the average speed of traffic. This is achieved by ensuring the vehicle passes as many vehicles as pass it.

Average Car

This is a less restrictive survey than the floating car in that the driver does not endeavour to pass as many vehicles as pass it. Instead, the driver travels according to their best judgement as to the traffic stream's speed.

Maximum Car

With this technique the driver travels at the posted speed limit unless impeded by traffic.

Chase Car

The 'chase car' technique sees individual vehicles randomly selected from the traffic stream and followed. This gives a sample of the performance of actual vehicles in the traffic stream.

© 2001 Data Collection Ltd.

ANALYSING TRAVEL TIME DATA

The travel time survey gives the time and distance travelled. It is advisable to establish check points along the survey route. This enables the data to be analysed for individual sections. These check points are best established using the ROMDAS Location Reference Point survey. This sees the chainage of the check points determined relative to the start point. During the survey the operator resets the chainage at each check point thereby providing a record of the location.

The travel time data can be represented in several ways:

Cumulative Travel Time

For a journey the cumulative travel time from the start to each check point is established. It is often plotted against chainage.

Average Section Speed

The average section speed is defined as the distance between check points divided by the time between check points.

Average Journey Speed

The average journey speed is the cumulative distance divided by the cumulative time.

Stopped Time

The time that the vehicle is stopped is an indicator of the level of service in the 1985 Highway Capacity Manual, although it tends to be established based on intersection surveys as opposed to test vehicle surveys.

It is also useful to record the *reason* that the vehicle was stopped – queuing, traffic signals, etc.

TRAFFIC CONGESTION ANALYSIS AND MODELLING

Introduction

Traffic congestion leads to a decrease in vehicle speeds and an increase in interactions. These interactions manifest themselves as higher levels of acceleration and deceleration. The ROMDAS system will collect data that will allow for an accurate assessment of traffic congestion.

The discussion which follows is oriented towards the use of congestion in economic appraisals, although the principles apply to other traffic engineering applications as well. It is focused around the forthcoming World Bank 'Highway Development and Management Model' – HDM-4 – which the ROMDAS was specifically designed to collect the input data for. Details of the basic research are found in NDLI (1995)[1], updated in Bennett and Greenwood (1999)[2].

[1] NDLI (1995). Modelling Road User Effects in HDM-4. Final Report ADB RETA-5549. N.D. Lea International, Vancouver, B.C.

[2] Bennett, C.R. and Greenwood, I.D. (1999). Modelling Road User and Environmental Effects in HDM-4. Report to the International Study of Highway Development and Management Tools, PIARC, Paris, France.

© 2001 Data Collection Ltd.

Congested Speeds

The speed-flow model adopted for motorised transport in HDM-4 is the "three-zone" model proposed by Hoban, et. al. (1994)[1]. This model is illustrated in Figure K.1.

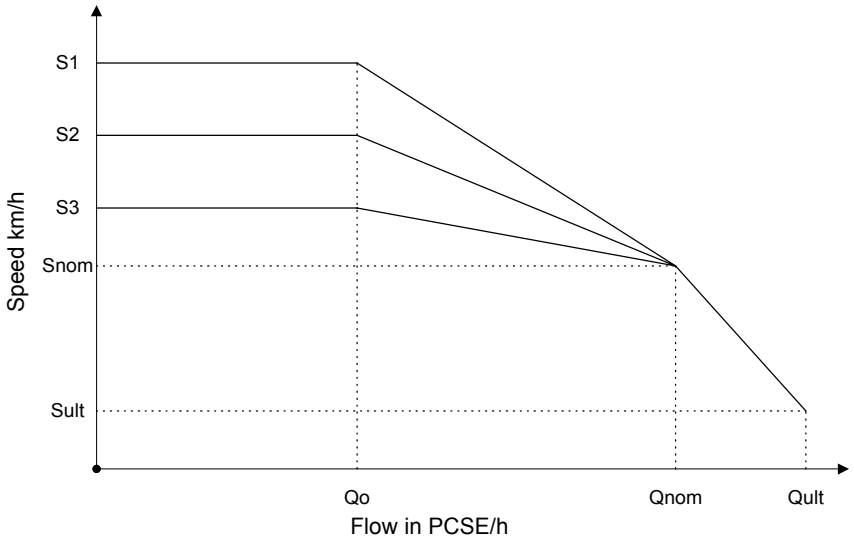


Figure K.1: HDM-4 Speed-Flow Model

The following notation applies to Figure K.1:

Qo	is the flow level below which traffic interactions are negligible in PCSE/h
Qnom	is the nominal capacity of the road in PCSE/h
Qult	is the ultimate capacity of the road for stable flow in PCSE/h
Snom	is the speed at the nominal capacity in km/h
Sult	is the speed at the ultimate capacity in km/h
S1 to S3	are the free flow speeds of different vehicle types in km/h
PCSE	are passenger car space equivalents (see below)

The model predicts that below a certain volume there are no traffic interactions and all vehicles travel at their free speeds[2]. Once traffic interactions commence, the speeds of the individual vehicles decrease until the nominal capacity where all vehicles will be travelling at the speed of the slowest vehicle class. The speeds can then further decrease towards the ultimate capacity beyond which unstable flow will arise.

The HDM-4 speed-flow model departs from traditional speed flow models through its use of *passenger car space equivalents* (PCSE) instead of passenger car units (PCU) or veh/h. The PCSE reflect the differences in space occupied by each vehicle type on the road, which directly affects road capacity (Hoban, et al., 1994). The PCSE are used because the model already considers the differences in speeds by vehicle type which, along with space, are implicitly considered by PCU factors.

Hoban, et al. (1994) indicate that the key parameters for use in the model vary depending upon the road type and width. Table K.1 lists the recommended values for these

[1] Hoban, C.J., et al. (1994). Economic Analysis of Road Improvement Projects with Congested Traffic. World Bank Publications, Washington, D.C.

[2] The value for Qo can be set to 0 which results in traffic interactions arising even at low flows. This has been observed on some roads, particularly those with high levels of non-motorised traffic.

© 2001 Data Collection Ltd.

parameters. The values for Q0 and Qnom are expressed relative to Qult. Hoban, et. al. (1994) suggest that the nominal speed is equal to 85 per cent of the free speed of the slowest vehicle.

Table K.1
Speed-Flow Model Parameters by Road Type

Road Type	Width (m)	Qo/ Qult	Qnom/ Qult	Qult (PCSE/h)	Sult (km/h)
Single Lane Road	< 4	0.0	0.70	600	10
Intermediate Road	4 to 5.5	0.0	0.70	1800	20
Two Lane Road	5.5 to 9	0.1	0.90	2800	25
Wide Two Lane Road	9 to 12	0.2	0.90	3200	30
Four Lane Road	>12	0.4	0.95	8000	40

Source: Hoban, et. al. (1994)

Theoretical Basis for Congestion VOC Modelling in HDM-4

The HDM-4 speed-flow model presented in Figure K.1 shows that as flows increase, there is an increase in vehicle interactions and a decrease in speeds. These interactions are accompanied by an increase in the frequency and magnitude of the vehicle accelerations and decelerations. The HDM-4 congestion model is built around this theory.

The magnitude of vehicle interactions are to be represented in HDM-4 by the acceleration noise, i.e. the standard deviation of acceleration. The total acceleration noise for a vehicle can be considered to be comprised of the following two components:

$$\sigma a = \sqrt{\sigma at^2 + \sigma an^2}$$

where σa is the total acceleration noise in m/s^2
σat is the noise due to fast-moving vehicle interactions in m/s^2
σan is the natural noise ascribed to the driver and road in m/s^2

Figure K.2 illustrates the different acceleration distributions which arise with congested and uncongested conditions.

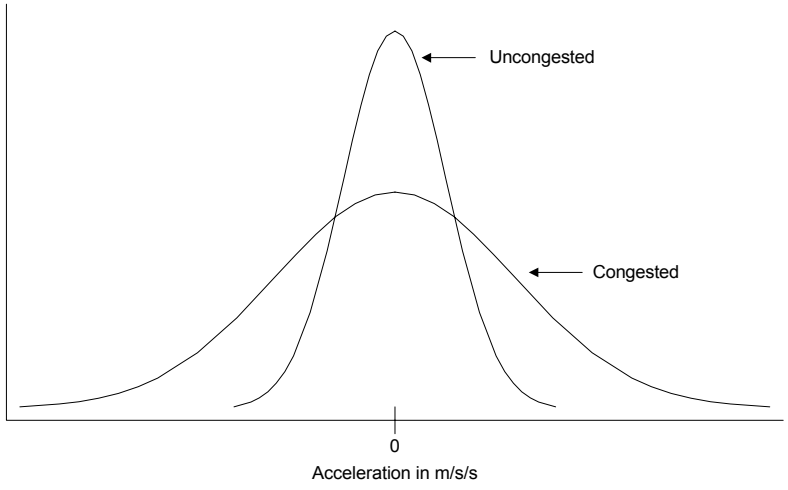


Figure K.2: Congested and Uncongested Acceleration Distributions

The natural noise can be described as:

© 2001 Data Collection Ltd.

$$\sigma an = f(\sigma adr, \sigma aal, \sigma asf, \sigma anmt, \sigma airi)$$

where σadr is the noise due to natural variations in the driver's speed in m/s^2
σaal is the noise due to the road alignment in m/s^2
σasf is the noise due to side friction in m/s^2
$\sigma anmt$ is the noise due to non-motorised transport in m/s^2
$\sigma airi$ is the noise due to roughness in m/s^2

In HDM-4 traffic noise is considered to be due to motorised transport. On the basis of previous research and experiments conducted by the ISOHDM HTRS team in Malaysia, the following equation was developed which gives the traffic noise as a function of relative flow – namely the volume to capacity ratio (NDLI, 1995):

$$\sigma at = \sigma atmax \frac{1.04}{1+e^{(a0+a1RELFLOW)}}$$

$$RELFLOW = \frac{Q}{Qult}$$

where RELFLOW is the relative flow (i.e. volume to capacity ratio)
a0 and a1 are regression coefficients quantified as:

$$a0 = 4.2 + 23.5 \left(\frac{Qo}{Qult}\right)^2$$

$$a1 = -7.3 - 24.1 \left(\frac{Qo}{Qult}\right)^2$$

Figure K.3 illustrates the predictions for various relative flows.

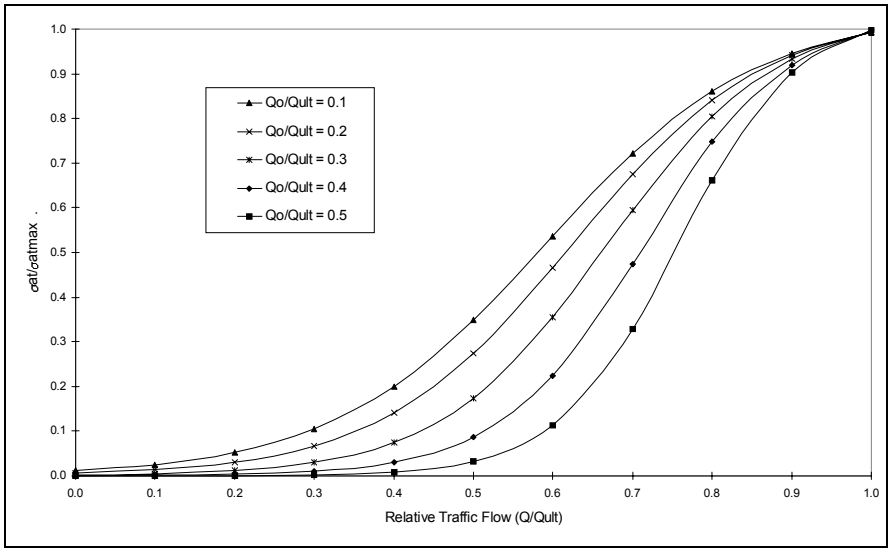


Figure K.3: Effect of Relative Flow on Traffic Noise

In HDM-4 the driver noise (σadr) and the alignment noise (σaal) are combined into a single value as it is difficult to differentiate between these two components. The other three components of natural noise — side friction (σasf), non-motorised transport ($\sigma anmt$) and roughness ($\sigma airi$) — will be modelled as linear functions such as those shown in Figure K.4. The maximum values preliminarily estimated for these components are:

© 2001 Data Collection Ltd.

$\sigma asf = 0.20\ m/s^2$
$\sigma anmt = 0.40\ m/s^2$
$\sigma airi = 0.30\ m/s^2$

The total natural noise is given by:

$$\sigma an = \sqrt{\max((\sigma adr^2 + \sigma aal^2), \sigma asf^2, \sigma asmt^2, \sigma airi^2)}$$

These maximums apply at side friction and non-motorised transport ratios of 1.0 and a roughness of 20 IRI m/km.

Using the above equations, the total acceleration noise at any relative flow can be characterised by the natural noise (σan) and the maximum traffic noise (σatmax).

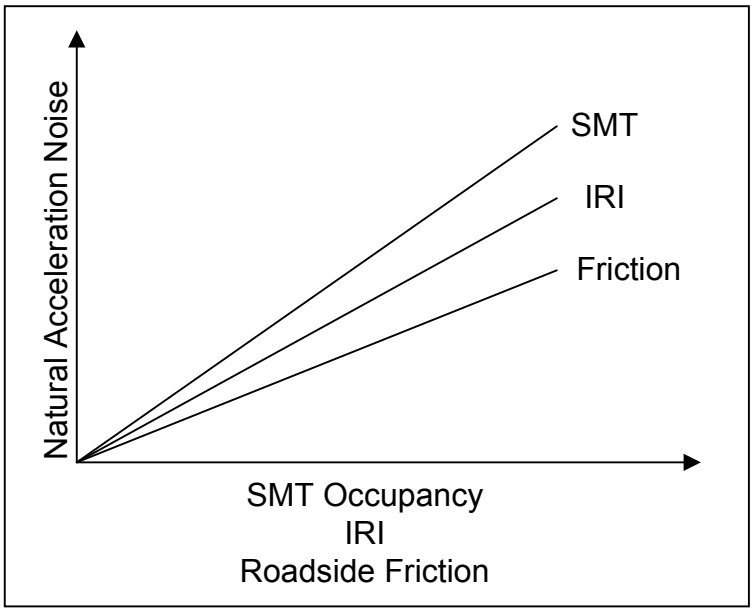


Figure K.4: HDM-4 Natural Noise Models

The maximum traffic noise is calculated as:

$$\sigma atmax = \sqrt{\sigma a\,max^2 - \sigma an^2}$$

Experiments were conducted in Malaysia with cars, medium trucks and buses led to a value of 0.60 m/s^2 being recommended for the maximum total acceleration noise (σamax) and a minimum value of 0.10 m/s^2 for the natural noise. These were adopted as the default parameters for all vehicle classes.

Using ROMDAS to Calibrate the HDM-4 Congestion Model

ROMDAS has been specifically designed to collect the necessary data to calibrate the HDM-4 congestion model.

The calibration exercise should focus on the two extreme values of the traffic noise: the natural noise and the maximum traffic noise. These values can be established by

© 2001 Data Collection Ltd.

conducting surveys on high standard roads with little traffic and on the same roads under highly congested conditions. By eliminating stopped time the noise can be directly calculated from the ROMDAS output.

In the same manner the noise can be established by conducting surveys on roads with varying alignments, surface or traffic conditions. These will allow for the other components of the HDM-4 model to be quantified.

© 2001 Data Collection Ltd.

ANNEX L CUSTOM DATABASES

© 2001 Data Collection Ltd.

dROAD

1. INTRODUCTION

The dROAD import routine was originally developed for N.D. Lea International Ltd. and the Thailand Department of Highways. It is thus specifically geared towards the data collection approach on that project, although it will work with other dROAD applications. Since only roughness data were collected, the routine does not currently import keyboard rating data.

2. PREPARATION OF IMPORT FILES

2.1 Create Master Log File

Before the data can be imported, it is necessary to prepare a Master Road File. This file contains a list of Road ID (ROAD_ID) values as well as other data.

The file is created from the individual survey logs. These logs are created each time a road section is surveyed. They are combined into a single file called RLMASTER.DBF as described in Chapter 13 under **DATA MANAGEMENT|MISCELLANEOUS FILES|PROCESS DAILY SURVEY LOGS|CREATE MASTER SURVEY LOG FILE**.

The RLMASTER file is sorted by increasing ROAD_ID.

2.2 Check for Duplicates

The RLMASTER.DBF file must contain only a single set of data for each ROAD_ID, otherwise the same road section has been surveyed twice and one set of data should not be included in the database.

The RLMASTER.DBF file is checked for duplicates using the option under **DATA MANAGEMENT|MISCELLANEOUS FILES|PROCESS DAILY SURVEY LOGS|CHECK MASTER SURVEY LOG FILE**. This results in a file called RLDUPLCT.DBF and an identical file called RLDUPLCT.TXT. These contain a list of all road sections with duplicate ROAD_ID numbers.

The file should be checked and the sections which should be excluded from the importing identified.

© 2001 Data Collection Ltd.

2.3 Remove Duplicates

The final step is to remove duplicate sections from the RLMASTER.DBF file. This is done using the option under **DATA MANAGEMENT|MISCELLANEOUS FILES|PROCESS DAILY SURVEY LOGS|EDIT MASTER SURVEY LOG FILE**.

The duplicate records from 2.2 above should be located in the RLMASTER.DBF file and deleted by pressing the DEL key.

3. PREPARATION OF dROAD FILES

The import routine produces two files which contain the data items and the road sections. These files are called LDxxxxxx and SDxxxxxx respectively, where xxxxxx is the file name for the road being analysed (e.g. the raw ROMDAS data would be stored as RRxxxxxx). The structures of these two files are as follows:

Data Items: LDxxxxxx

Description	Name	Type	Width	Dec.
Element ID	ELEM_ID	C	16	
Date	DATE	D	8	
Raw Roughness	RAW_COUNT	N	6	
Speed	SPEED	N	6	
Raw Roughness per km	RAW_CNT_KM	N	4	
Calibrated Roughness per km	CALIB_RGH	N	8	2

Section Data: SDxxxxxx

Description	Name	Type	Width	Dec.
Road Element ID	RD_ELEMENT	C	40	
From Element	FR_ELEMENT	C	65	
From Offset	FR_OFF	N	10	3
From Point Perspective	FR_PT_PER	C	10	
From Point Element	FR_PT_ELEM	C	65	
To Element	TO_ELEMENT	C	65	
To Offset	TO_OFF	N	10	3
To Point Perspective	TO_PT_PER	C	10	
To Point Element	TO_PT_ELEM	C	65	
Piece Element	PIECE_ELEM	C	16	

© 2001 Data Collection Ltd.

Before data can be imported it is necessary to set up the dROAD import file structure. This is done under **SETUP|CUSTOM DATABASE STRUCTURES|dROAD FILE STRUCTURE.**

The data required are as follows:

- **Road Element ID Field Width** is applied in the SDxxxxxx section data file (RD_ELEMENT).
- **Section Element ID Field Width** is applied in the LDxxxxxx data file (ELEM_ID) as well as for the Piece Element in the SDxxxxxx section data file (PIECE_ELEM). It should be noted that the Piece Element and the Section Element are identical.
- **Element Name Size** is the number of characters from the Road Element ID to use in constructing the Piece Element. For example, if the Road Element ID was 12345678 and this value was set to 5 only 12345 would be used in the Piece Element.
- **Use LRP Name in Piece Element**. The user can use the LRP name in constructing the Piece Element. The size is the number of characters from the name to use. This option works best when the LRPs are numeric as opposed to characters (eg. LRP 1450, 1451, etc.).
- **Include Date Field.** When dealing with multiple surveys over several years it is advisable to have the date available in the database.

The Piece Element is the critical data item. They are established from the ROAD_ID, the LRP number (optional, but recommended) and the start offset. The default structure for this is:

aaaaaaaaaa/bbbb/ccccc

where aaaaaaaaaaaa is the element name from the ROAD_ID
bbbb is from the LRP number
ccccc is the start chainage in m

For example, if the ROAD_ID was 00010100-100, the LRP number was 7, and the chainage was starting at 0.5 km the Piece Element would be:

00010100-100/0007/00500

Once the above preliminary steps have been completed the data can be processed. This is done by selecting the option **DATA MANAGEMENT|EXTRACT DATA TO CUSTOM SYSTEMS|PREPARE DROAD IMPORT FILE.**

The user is prompted for the name of the Master Log file to use (default = RLMASTER) and whether or not to import processed roughness data. There are two options:

- If the roughness data have already been processed, enter Y here. You will be asked which RCxxxxxx.DBF files to import.
- If the roughness data have not been processed, enter N. You will be asked which calibration file to apply to the raw data and then the name of the raw roughness file to process.

The data will be exported into the necessary LDxxxxxx and SDxxxxxx files which are stored in the EXPORT subdirectory.

© 2001 Data Collection Ltd.

Philippines RIMSS System

1. INTRODUCTION

The RIMSS import routine was developed for Africon Consultants Ltd. for the Philippines Department of Highways RIMSS Project. The project consisted of a 29,000 km video and GPS centreline survey which also recorded roughness. The positions of LRPs was established at regular intervals and digital photographs were taken of each LRP. The data had to be fitted to an existing node and section system which had been already established.

2. PREPARATION OF RIMSS DATABASE

The objective of the data processing was to replace survey information with standard data from the RIMSS database—specifically section and node names. The LRPs had to be renamed to the appropriate convention and the digital photo numbers also renamed. The key for achieving this was the RIMSS database. This was a file extracted from the RIMSS node and section database describing the basic road data.

© 2001 Data Collection Ltd.

ANNEX M ROMDAS FILE STRUCTURES

Location Reference Point Data

The LRP data are stored in the RPxxxxxx.DBF files. Table M.1 an example of the contents of such a file.

Table M.1: Example of Location Reference Point Data

RECTYPE	LRP_NUMBER	LRP_DISPL	LRP_DESC
1	0	0	SH30
2	0	0	State Highway 30
3	0	121137	09/04/95
4	0	0	CRB
5	0	0	DE1600
12	1	0	SH10 Intersection
12	2	907	BP Petrol Station
12	3	2072	St Matthew's Church
12	4	2525	SH30 Intersection

There are four fields and, depending upon the RECTYPE, each field contains a different type of data. The following are the data associated with each RECTYPE:

RECTYPE	1
LRP_NUMBER	File name
LRP_DISPL	Daily survey number
LRP_DESC	Road identification

RECTYPE	2
LRP_NUMBER	User defined field 1
LRP_DISPL	Reserved for future use
LRP_DESC	Road description

RECTYPE	3
LRP_NUMBER	User defined field 1
LRP_DISPL	Time
LRP_DESC	Date

RECTYPE	4
LRP_NUMBER	User defined field 1
LRP_DISPL	System debugging value
LRP_DESC	Operator
PHOTO_NAME	ROMDAS Version Number

RECTYPE	5
LRP_NUMBER	Reserved for future use
LRP_DISPL	Direction (1 = Increment; 2 = Decrement)
LRP_DESC	Vehicle

RECTYPE	12
LRP_NUMBER	LRP number
LRP_DISPL	Chainage of LRP
LRP_DESC	Description of LRP

© 2001 Data Collection Ltd.

Roughness Survey Data

The roughness survey data are stored in the RRxxxxxx.DBF files. Table M.2 illustrates the data for a simulated roughness survey.

Table M.2: Example of ROMDAS Roughness Survey Data

RECTYPE	CHAINAGE	LRP_ NUMBER	ROUGH_1	ROUGH_2	SPEED	COMMENT
1	USER_1		2538		0	State Highway 30
2	USER_2		0		1	CRB
3	USER_3		10		250	DE1600
4	04/12/98		204819		0	YMY1YYRPSH30 YY
5	SH30		0		0	
10	250	1	6	5	44	End of Interval
10	500	1	6	4	46	End of Interval
12	930	2	10	12	51	Manual LRP reset #2 BP Petrol Station
17	907	2	4	7	51	LRP #2 Chainage BP Petrol Station
10	250	2	6	7	48	End of Interval
15	312	2	1	1	40	Exclude BI count
15	390	2	1	1	42	Include BI count
13	500	2	4	5	45	End of Interval
10	750	2	6	7	46	End of Interval
12	1160	3	10	9	44	Manual LRP reset #3 St Matthew's Church
17	1165	3	4	4	44	LRP #3 Chainage St Matthew's Church
14	236	3	5	6	35	Manual Paused
12	448	4	13	11	43	Manual LRP reset #4 SH30 Intersection
17	453	4	4	5	43	LRP #4 Chainage SH30 Intersection
10	140	4	3	2	46	Manual End

The following are the data items associated with each RECTYPE:

RECTYPE	1
CHAINAGE	User supplied field number 1
LRP_NUMBER	Survey number that day
ROUGH_1	System debugging value
ROUGH_2	Reserved for future use
SPEED	Survey start distance
COMMENT	Road description

RECTYPE	2
CHAINAGE	User supplied field number 2
LRP_NUMBER	File name
ROUGH_1	Length of section to be surveyed
ROUGH_2	Reserved for future use
SPEED	Direction - 1=Increment; 2=Decrement
COMMENT	Name of operator

RECTYPE	3
CHAINAGE	User supplied field number 3

© 2001 Data Collection Ltd.

LRP_NUMBER	Reserved for future use
ROUGH_1	Minimum speed in km/h
ROUGH_2	Reserved for future use
SPEED	Sampling interval
COMMENT	Vehicle number
RECTYPE	4
CHAINAGE	Survey date
LRP_NUMBER	Reserved for future use
ROUGH_1	Survey start time
ROUGH_2	Reserved for future use
SPEED	Initial chainage
COMMENT	16 character LRP flag: whether to reset (Y or N) manual or auto resets (M or A) whether to beep (Y or N) LRP reset option (1 to 3) auto reset at sampling intervals (Y or N) equivalent BI on BI exclusion (Y or N) LRP file name (8 chars) include LRP chainage in file (Y or N) use LRP chainage in output (Y or N)
RECTYPE	5
CHAINAGE	ROMDAS Version Number
LRP_NUMBER	Reserved for future use
ROUGH_1	Reserved for future use
ROUGH_2	Reserved for future use
SPEED	Reserved for future use
COMMENT	Road identification
RECTYPE	10 and up
CHAINAGE	Chainage in m
LRP_NUMBER	LRP Number
ROUGH_1	Roughness since last chainage from BI #1
ROUGH_2	Roughness since last chainage from BI #2
SPEED	Speed in km/h
COMMENT	Comment

Keycode Survey Data

Table M.3 is an example of the keycode survey data file (RKxxxxxx.DBF). The data consist of the description of the event (from KEYCODE.DBF), the key pressed, the start and end chainages of the event (if it is a point event only the start chainage is given).

© 2001 Data Collection Ltd.

Table M.3: Example of Keycode Survey Data

RECTYPE	EVENT_DESC	EVENT	EVENT_ STRT	EVENT_ END	LRP_ START	LRP_ END
1	SH30		1	0		
2	State Highway 30		0	0		
3	04/10/95		0	0		
4	CRB		204819	0		
5	DE1600		0	0		
11	Medium Cracking	D	142	246	1	2
11	AC Surface	A	788			
12	Manual LRP reset #2 BP Petrol Station		907			
11	High Cracking	F	788	828	2	4
12	Manual LRP reset #3 St Matthew's Church		2072			
12	Manual LRP reset #4 SH30 Intersection		2525			

The header data in this file are as follows:

RECTYPE	1
EVENT_DESC	Road identification
EVENT	Reserved for future use
EVENT_STRT	Direction: 1=Increment; 2=Decrement
EVENT_END	Reserved for future use
LRP_START	User defined field 1
LRP_END	Reserved for future use

RECTYPE	2
EVENT_DESC	Road description
EVENT	Reserved for future use
EVENT_STRT	Reserved for future use
EVENT_END	Reserved for future use
LRP_START	User defined field 2
LRP_END	Reserved for future use

RECTYPE	3
EVENT_DESC	Date
EVENT	Reserved for future use
EVENT_STRT	Reserved for future use
EVENT_END	Reserved for future use
LRP_START	User defined field 3
LRP_END	Reserved for future use

RECTYPE	4
EVENT_DESC	Operator
EVENT	Reserved for future use
EVENT_STRT	Time
EVENT_END	Reserved for future use
LRP_START	File name
LRP_END	Reserved for future use

RECTYPE	5
EVENT_DESC	Vehicle
EVENT	ROMDAS Version Number
EVENT_STRT	Daily survey number
EVENT_END	Reserved for future use

© 2001 Data Collection Ltd.

LRP_START	Reserved for future use
LRP_END	Reserved for future use
RECTYPE	11
EVENT_DESC	Event description
EVENT	Key pressed
EVENT_STRT	Start chainage of event in m
EVENT_END	End chainage of event in m (0 if point event)
LRP_START	Start LRP number
LRP_END	End LRP number
RECTYPE	12
EVENT_DESC	LRP description
EVENT	Key pressed
EVENT_STRT	Chainage
EVENT_END	Reserved for future use
LRP_START	Reserved for future use
LRP_END	Reserved for future use

Survey Log Data

The RDxxxxxx.DBF file contains the survey log data. This is a record of every event which arose in the survey (*e.g.* the roughness sampling interval, keycode events, LRPs, *etc.*). The file contains the LRP number, the offset (in m) from the LRP of the event, the cumulative chainage (in m) and the cumulative time (in s) from the start of the survey to the event. This time is used in the video logging to establish the approximate frame number the event corresponds to. Table M.4 illustrates the data in this file for the roughness survey in Table M.2. The 5 line header contains the following data:

RECTYPE	CHAINAGE	C_CHAINAGE	C_TIME
1	Road Identification	User Code 1	Direction
2	Road Description	User Code 2	Not Used
3	Date	User Code 3	Not Used
4	Operator	Roughness File Name	Time (HHMMSS)
5	Vehicle	LRP File Name	Daily Survey Number

© 2001 Data Collection Ltd.

Table M.4: Example of Road Chainage Data File

LRP_NUMBER	CHAINAGE	C_CHAINAGE	C_TIME
	SH30	USER_1	1.0
	State Highway 30	USER_2	0.0
	04/10/95	USER_3	0.0
	CRB	RRSH30	164533.0
	DE1600	RPSH30	3
1	250	250	12.0
1	500	500	23.8
1	930	930	35.2
2	250	1180	51.5
2	750	1680	70.8
2	1160	2090	91.2
3	448	2538	105.7
4	140	2678	119.2

Roughness Vehicle Calibration Coefficients

The data in this file (CBxxxxxx.DBF) are used to convert the raw roughness data to calibrated roughnesses. Each roughness vehicle should have a unique file name. Chapter 5 describes defining the values in these files.

The file consists of the speeds below which the data applies to and a series of regression model coefficients. Different coefficients are used for BI #1 and BI #2. An example of the contents is given in Table M.5.

Table M.5: Example of Roughness Calibration File

BI_ NUM	SPEED _LIM	CALIB_ A0	CALIB_ A1	CALIB_ A2	CALIB_ A3	CALIB_ A4	CALIB_ A5	CALIB_ A6	VEHICLE
1	10.0	0.0	0.1	1.0	0.0	0.0	0.0	0.0	DE1600
1	50.0	0.0	0.25	1.0	0.0	0.0	0.0	0.0	DE1600
1	100.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	DE1600
2	10.0	0.0	0.1	1.0	0.0	0.0	0.0	0.0	DE1600
2	50.0	0.0	0.25	1.0	0.0	0.0	0.0	0.0	DE1600
2	100.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	DE1600

Calibrated Roughness Survey Results

This file (RCxxxxxx.DBF) contains the raw roughness survey data which has been processed using the roughness calibration coefficients in the CBxxxxxx.DBF file. The coefficients applied depend upon the speed of the vehicle during the survey. Table M.6 is an example of this file using the raw data from Table M.2 and the calibration coefficients from Table M.5.

The first record gives the file name and the calibration coefficient file number. The subsequent records consist of the start and end chainages of the sampling intervals, the current LRP number, the average speed of the vehicle over the sampling interval in km/h, the number of raw counts over the sampling interval, the raw counts on a per kilometre basis, and well as the calibrated roughness. These values are given for each of BI #1 and BI #2, or BI #1 only if there is only a single BI. The C_ROUGH is the calibrated roughness. With two BI it is the average of BI #1 and BI #2; with one BI it is the same as C_ROUGH_1. It should be noted that in the example the end chainages recorded have been replaced with the end chainages from the LRP file. This ensures that the data are correlated between subsequent surveys (see the discussion of LRPs in Chapter 2).

© 2001 Data Collection Ltd.

Not shown in Table M.7 are additional fields which are included in data base. These contain the calibration coefficients used in calculating the calibrated roughness (see Table M.5).

Table M.6: Example of Calibrated Roughness Data

CHAIN _FROM	CHAIN _TO	LRP_ NUMBER	SPEED	RAW_C_1	RAW_C_2	RAW_C_1 _KM	RAW_C_2 _KM	C_ ROUGH_1	C_ ROUGH_2	C_ ROUGH
RRSH16	CBDE1600									
0	250	1	44	6	5	24	20	6.00	5.00	5.50
250	500	1	46	6	4	24	16	6.00	4.00	5.00
500	907	1	51	10	12	24	29	6.00	7.25	6.63
0	250	2	48	6	7	24	28	6.00	7.00	6.50
250	500	2	45	4	5	16	20	4.00	5.00	4.50
500	750	2	46	6	7	24	28	6.00	7.00	6.50
750	1165	2	44	10	9	24	21	6.00	5.25	5.63
0	453	3	43	13	11	28	24	7.00	6.00	6.50
0	140	4	46	3	2	21	14	5.25	3.50	4.38

Speed Survey Data

The speed survey data are stored in the RTxxxxxx.DBF files. Table M.8 illustrates the data for a simulated speed survey.

The header RECTYPE data are the same as with the roughness surveys. The RECTYPE 20 have the actual data which are as follows:

RECTYPE	20
C_CHAINAGE	Cumulative chainage in m
C_TIME	Cumulative time in s
LRP_NUMBER	LRP Number
COMMENT	Comment

© 2001 Data Collection Ltd.

Table M.8: Example of ROMDAS Speed Survey Data

RECTYPE	C_CHAINAGE	C_TIME	LRP_NUMBER	COMMENT
1		0.00	0.00	Test Run
2		0.00	0.00	CB
3		10.00	0.00	DE1600
4	10/02/96	0.00	185919.00	NMY1YY YY
5	Test Run	0.00	0.00	
18	0	0.00	1	Survey Start LRP
20	28	1.05	1	
20	57	2.04	1	
20	85	3.03	1	
20	114	4.01	1	
20	142	5.00	1	
20	172	6.10	1	
20	201	7.09	1	
20	230	8.08	1	
20	258	9.07	1	
20	287	10.06	1	
20	309	11.07	1	Manual End

Speed and Acceleration Profiles

The file RSxxxxx.DBF contains the raw speed survey data which has been processed to prepare a speed and acceleration profile. Table M.9 is an example of this file using the raw data from Table M.8.

Table M.9: Example of Speed and Acceleration Profile Data

C_ CHAINAGE	C_TIME	LRP_ NUMBER	D_ CHAINAGE	D_TIM E	AVG_ SPEED	INST_ SPEED	INST_ ACCEL	COMMENT
0	0.00	1						
28	1.05	1	28	1.05	96.0	96.0		
57	2.04	1	29	0.99	100.6	105.5	2.65	
85	3.03	1	28	0.99	101.0	101.8	-1.02	
114	4.01	1	29	0.98	102.3	106.5	1.34	
142	5.00	1	28	0.99	102.2	101.8	-1.32	
172	6.10	1	30	1.10	101.5	98.2	-0.92	
201	7.09	1	29	0.99	102.1	105.5	2.04	
230	8.08	1	29	0.99	102.5	105.5	0.00	
258	9.07	1	28	0.99	102.4	101.8	-1.02	
287	10.06	1	29	0.99	102.7	105.5	1.02	
309	11.07	1	22	1.01	100.5	78.4	-7.44	

Transverse Profile Data

Table M.10 is an example of transverse profile data. In this example the TPL 'wings' were not used. This resulted in the values of 0.00 for sensors 1 to 5 and 26 - 30. The TPL header data are as follows:

© 2001 Data Collection Ltd.

RECTYPE	1
DESCRIPTION	Description
CHAINAGE	Reserved for future use
L_UPLIFT	Distance from edge for high point
L_DISP	Left wheelpath straight edge length
R_UPLIFT	Right wheelpath straight edge length
RECTYPE	2
DESCRIPTION	ROAD ID
CHAINAGE	Reserved for future use
RECTYPE	3
DESCRIPTION	Date
CHAINAGE	Wing configuration
RECTYPE	4
DESCRIPTION	Operator
CHAINAGE	Reserved for future use
RECTYPE	5
DESCRIPTION	Vehicle
CHAINAGE	Reserved for future use
LRPNUMBER	ROMDAS Version Number

IRI Elevation Profile

Table M.12 gives an example of the elevation profile data which is generated from the LPL profile, or any elevation profile from a profilometer. The CHAINAGE is the distance in m between elevation measurements and the ELEVATION is the profile elevation in mm.

Table M.12: Example of Elevation Profile Data

CHAINAGE	ELEVATION
0.1	304.3
0.2	303.8
0.3	303.6
0.4	302.7
0.5	302.2
0.6	301.5
0.7	301.4
0.8	299.1
0.9	297.9
1.0	296.6
1.1	293.8
1.2	293.3
1.3	293.5
1.4	291.5
1.5	289.2

© 2001 Data Collection Ltd.

Table M.10: Example of Transverse Profile Logger Data

DESCRIPTIO	TIME	SPEED	LRP_ NUMBER	CHAIN AGE	ELEV _1	ELEV _2	ELEV _3	ELEV _4	ELEV _5	ELEV _6	ELEV _7	ELEV _8	ELEV _9	ELEV _10	ELEV _11	ELEV _12	ELEV _13	ELEV _14
Calibration Survey 1	09:43:11	50.1	2	10.0	0.0	0.0	0.0	0.0	0.0	305.4	305.4	305.5	305.0	305.4	305.0	300.6	300.0	300.3
Calibration Survey 1	09:43:31	49.2	2	20.0	0.0	0.0	0.0	0.0	0.0	305.7	305.1	305.5	305.3	305.3	305.1	300.7	300.4	300.5
Calibration Survey 1	09:43:32	49.5	2	30.0	0.0	0.0	0.0	0.0	0.0	303	303.3	305.7	305.3	305.1	309.2	308.6	300.4	300.3
Calibration Survey 1	09:43:33	49.5	2	40.0	0.0	0.0	0.0	0.0	0.0	305.1	305.3	300.1	10.4	308.8	305.0	300.9	307.0	310..8
Calibration Survey 1	09:43:33	49.9	2	50.0	0.0	0.0	0.0	0.0	0.0	305.0	305.5	305.3	305.8	305.4	305.0	300.7	300.9	300.8
Calibration Survey 1	09:43:34	50.0	2	60.0	0.0	0.0	0.0	0.0	0.0	305.5	305.2	305.5	305.4	305.4	305.0	300.6	300.0	300.4
Calibration Survey 1	09:43:35	49.8	2	70.0	0.0	0.0	0.0	0.0	0.0	305.3	305.2	305.0	311.0	310.4	305.0	300.4	309.1	310.2
Calibration Survey 1	09:43:36	49.9	2	80.0	0.0	0.0	0.0	0.0	0.0	305.6	305.	3000	310.0	309.0	305.0	311.5	307.3	308..0
Calibration Survey 1	09:43:37	50.2	2	90.0	0.0	0.0	0.0	0.0	0.0	305.6	305.4	305.5	305.0	305.3	305.1	300.6	300.4	300.7
Calibration Survey 1	09:43:38	50.0	2	100.0	0.0	0.0	0.0	0.0	0.0	305.7	305.6	305.3	300,5	319.7	305.0	300.6	308.1	310.4
Calibration Survey 1	09:43:39	50.1	2	110.0	0.0	0.0	0.0	0.0	0.0	305.8	305.3	305.7	305.4	305.4	307.4	300.6	300.0	300.6

ELEV _15	ELEV _16	ELEV _17	ELEV _18	ELEV _19	ELEV _20	ELEV _21	ELEV _22	ELEV _23	ELEV _24	ELEV _25	ELEV _26	ELEV _27	ELEV _28	ELEV _29	ELEV _30	ELEV _31	XF_ METHOD	ROLL	BAR_ ROAD	CROSS FALL	XF_ STAT
300.1	300.0	300.6	300.2	300.6	305.6	305.1	305.3	314.2	314.1	314.9	0.0	0.0	0.0	0.0	0.0	305.0	1	0.00	6.03	6.03	0.0
300.4	300.4	300.6	300.2	300.0	305.3	305.2	305.2	314.3	314.2	315.0	0.0	0.0	0.0	0.0	0.0	305.0	1	3.20	6.04	9.24	0.0
300.3	300.6	307.4	300.2	300.4	305.6	309.2	308.3	314.6	314.2	314.4	0.0	0.0	0.0	0.0	0.0	305.0	1	0.10	0.00	0.10	0.0
300.7	300.4	300.6	300.8	300.6	305.8	305.1	300.9	310.7	310.1	307.3	0.0	0.0	0.0	0.0	0.0	305.0	1	0.60	0.00	0.60	0.0
300.5	300.1	300.6	300.2	300.6	305.3	305.8	305.3	314.1	314.2	314.9	0.0	0.0	0.0	0.0	0.0	305.0	1	3.20	-1.81	1.39	0.0
300.7	300.5	300.6	300.2	300.0	305.0	305.1	305.3	314.2	314.2	305.6	0.0	0.0	0.0	0.0	0.0	305.0	1	3.10	0.19	3.29	0.0
309.2	300.1	300.5	310.1	300.8	305.4	305.1	3001	311.5	310.	329.0	0.0	0.0	0.0	0.0	0.0	305.0	1	0.80	0.19	0.99	0.0
300.5	300.0	300.5	309.0	300.6	305.6	305.2	310.3	38.7	314.2	314.9	0.0	0.0	0.0	0.0	0.0	305.0	1	1.90	0.19	2.09	0.0
300.5	300.5	300.6	300.2	300.0	305.3	305.1	305.3	314.6	314.2	315.0	0.0	0.0	0.0	0.0	0.0	305.0	1	1.90	0.20	2.10	0.0
300.6	300.4	300.6	300.6	300.0	305.9	305.1	305.1	311.8	308.	317.4	0.0	0.0	0.0	0.0	0.0	305.0	1	0.10	0.21	0.31	0.0
300.0	300.1	300.6	300.2	300.0	305.6	305.1	305.2	314.5	314.2	315.0	0.0	0.0	0.0	0.0	0.0	305.0	1	3.10	0.19	3.29	0.0

© 2001 Data Collection Ltd.

Daily Survey Log

This file contains the important header data for each survey run, including file names and other information. It serves as a daily record of the surveys. A separate file is created for each day of survey, with the file name Rlddmmyy, where dd is the day; mm the month; yy the year. The file also includes details on ROAD ID; the survey file name; the LRP file name; the description; and what surveys were done. Table M.13 is an example of the file contents. The data have been transposed for clarity. It will be noted that for each survey (1 to 5) different surveys were done.

Table M.13: Example of Daily Survey Log

SURVEY	1	2	3	4	5
DATE	19981218	19981218	19981218	19981218	19981218
ROAD_ID	3A	3B	3C	3D	3E
SURV_FILE	RR3A	RR3B	RR3C	RR3D	RR3E
LRP_FILE				RP3D	
DESCRIPTIO	3A	3B	3C	3D	3E
SECTLEN	0	0	0	0	0
SUR_VIDEO	F	F	T	T	F
SUR_GPS	F	T	F	F	F
SUR_TPL	F	F	T	F	F
SUR_ROUGH	T	T	T	T	T
SUR_LRP	F	F	F	F	F
SUR_KEY	F	F	F	F	F
SUR_SPEED	F	F	F	F	F
SUR_SKID	F	F	F	F	F
OPERATOR	CRB	CRB	CRB	CRB	CRB
VEHICLE	DE1600	DE1600	DE1600	DE1600	DE1600

Road Description Data

The file ROADDAT.DBF contains the road description data. These data consist of the fields that are entered at the start of a roughness survey:

- Road ID;
- Survey File Name;
- LRP File Name;
- Description;
- LRP Reset;
- User defined fields.

Instead of having the user define these data during the survey, the file would be created before the survey (see Chapter 5) and the user would only have to enter the Road ID. The data associated with the Road ID would then be entered into the appropriate fields in the opening screen. Table M.14 illustrates the contents of this file, with two optional user defined fields.

© 2001 Data Collection Ltd.

Table M.14: Example of Road Description Data

ROADID	SURV_FILE	LRP_FILE	DESCRIPTIO	LRPRESET	USER_1	USER_2	USER_3
SH30	RRSH30	RPSH30	Highway 30	Y	Rodney	Kumeu	
SH31	RRSH32	RPSH32	Highway 32	Y	Rodney	Kumeu	
PEAKRD	RRPEAKRD		Peak Road	N	Rodney	Kumeu	
SH20	RRSH20	RPSH20	Highway 20	Y	Rodney	Kumeu	

FILE STRUCTURES

The following summarises the structures of the ROMDAS files:

Field Name	Type	Size	Dec.	Field Contents
CBxxxxxx.DBF - Calibrated Roughness Coefficients				
BI_NUM	N	1		BI Number
SPEED_LIM	N	3	0	Upper Speed to Apply Equation To
CALIB_A0	N	11	6	Calibration Coefficient - A0
CALIB_A1	N	11	6	Calibration Coefficient - A1
CALIB_A2	N	11	6	Calibration Coefficient - A2
CALIB_A3	N	11	6	Calibration Coefficient - A3
CALIB_A4	N	11	6	Calibration Coefficient - A4
CALIB_A5	N	11	6	Calibration Coefficient - A5
CALIB_A6	N	11	6	Calibration Coefficient - A6
VEHICLE	C	10		Vehicle ID
KEYCODE.DBF - Keycode Event				
EVENT	C	1		Event key
EVENT_TYPE	C	1		Type of Event (C or P)
STOP_BI	L	1		Stop Roughness Meter (T or F)
VEHICLE	L	1		If Event is Vehicle for Moving Traffic Survey
DIRECTION	N	1		Direction of Vehicle in Moving Traffic Survey
REL_SPEED	N	3		Relative Speed of Vehicle in M.T.S. (km/h)
EVENT_DESC	C	40		Event Description
LRP_DEF.DBF - LRP Predefinition File				
LRP_KEY	C	6		LRP Key (User Definable Size)
LRP_DESC	C	50		LRP Description
MSGENGL.DBF and MSGLOCAL.DBF - Menus				
LENGTH	N	2	0	Length of Menu
TEXT	C	80		Text of Menu
ROADDAT.DBF - Road Description Data				
ROAD_ID	C	64		Road ID
SURV_FILE	C	8		Name of Survey Data File
LRP_FILE	C	8		Name of LRP File
DESCRIPTIO	C	50		Road Description
LRPRESET	C	1		Use LRP Resets (Y/N)
USER_1	C	10		User Defined Field - 1
USER_2	C	10		User Defined Field - 2
USER_3	C	10		User Defined Field - 3

© 2001 Data Collection Ltd.

RCxxxxxx.DBF - Calibrated Roughness				
CHAIN_FROM	C	8		Start of Sampling Interval
CHAIN_TO	C	8		End of Sampling Interval
LRP_NUMBER	C	5		Current LRP
SPEED	N	3	0	Average Speed in km/h
RAW_C_1	N	3	0	BI #1 Roughness in counts/sampling interval
RAW_C_2	N	3	0	BI #1 Roughness in counts/sampling interval
RAW_C_1_KM	N	4	0	BI #1 Raw Roughness in counts/km
RAW_C_2_KM	N	4	0	BI #2 Raw Roughness in counts/km
C_ROUGH_1	N	8	2	BI #1 Calibrated Roughness in IRI m/km
C_ROUGH_2	N	8	2	BI #2 Calibrated Roughness in IRI m/km
CALIB_RGH	N	8	2	Calibrated Roughness in IRI m/km
ROAD_ID	C	64		Road ID Number
C_1_A0	N	11	6	BI #1 Calibrated Roughness Coefficient a0
C_1_A1	N	11	6	BI #1 Calibrated Roughness Coefficient a1
C_1_A2	N	11	6	BI #1 Calibrated Roughness Coefficient a2
C_1_A3	N	11	6	BI #1 Calibrated Roughness Coefficient a3
C_1_A4	N	11	6	BI #1 Calibrated Roughness Coefficient a4
C_1_A5	N	11	6	BI #1 Calibrated Roughness Coefficient a5
C_1_A6	N	11	6	BI #1 Calibrated Roughness Coefficient a6
C_2_A0	N	11	6	BI #2 Calibrated Roughness Coefficient a0
C_2_A1	N	11	6	BI #2 Calibrated Roughness Coefficient a1
C_2_A2	N	11	6	BI #2 Calibrated Roughness Coefficient a2
C_2_A3	N	11	6	BI #2 Calibrated Roughness Coefficient a3
C_2_A4	N	11	6	BI #2 Calibrated Roughness Coefficient a4
C_2_A5	N	11	6	BI #2 Calibrated Roughness Coefficient a5
C_2_A6	N	11	6	BI #2 Calibrated Roughness Coefficient a6
RDxxxxx.DBF - Survey Log Data				
RECTYPE	C	2		Record Type
LRP_NUMBER	C	5		Current LRP
CHAINAGE	C	64		Current Chainage
C_CHAINAGE	C	8		Cumulative Chainage
C_TIME	N	8	1	Cumulative Time
RGxxxxxx.DBF - GPS Data				
RECTYPE	C	2		Record Type
LRP_NUMBER	C	10		LRP Number
CHAINAGE	N	9	1	Chainage in m
Latitude	C	13		Latitude (ddd.mmm.ssss)
Longitude	C	13		Longitude (ddd.mmm.ssss)
Altitude	N	7	2	Altitude (m)
PDOP	N	6	2	Dilution of Precision
GDOP	N	6	2	Gometric Dilution of Precision
MERIT	N	1		Merit Number (adequacy of data)
DGPS_USED	L	1		If Differential Corrections Used
RHxxxxxx.DBF - GPS Ephemerous Data				
				Not implemented yet
RIxxxxxx.DBF - Rut Depth by Sampling Interval Data				
				Not implemented yet

© 2001 Data Collection Ltd.

RKxxxxxx.DBF - Keycode Rating				
RECTYPE	C	2		Record Type
EVENT_DESC	C	50		Event Description
EVENT	C	6		Event Keycode
EVENT_STRT	N	8	0	Start Chainage
LRP_START	C	10		LRP For Start Chainage
EVENT_END	N	8	0	End Chainage
LRP_END	C	10		LRP For End Chainage
RLxxxxxx.DBF - Survey Log				
SURVEY	N	2	0	Survey Number
DATE	D	8		Date
ROAD_ID	C	64		Road ID
SURV_FILE	C	10		Name of Survey Data File
LRP_FILE	C	10		Name of LRP File
DESCRIPTIO	C	64		Description
SECTLEN	N	8	0	Length of Section
SUR_VIDEO	L	1		If Video Survey Performed
SUR_GPS	L	1		If GPS Survey Performed
SUR_TPL	L	1		If TPL Survey Performed
SUR_ROUGH	L	1		If Roughness Survey Performed
SUR_LRP	L	1		If LRP Survey Performed
SUR_KEY	L	1		If Keycode Survey Performed
SUR_SPEED	L	1		If Speed Survey Performed
SUR_SKID	L	1		If Skid Resistance Survey Performed
OPERATOR	C	64		Operator Name
VEHICLE	C	64		Vehicle ID
RPxxxxxx.DBF - Location Reference Points				
RECTYPE	C	2	0	Record Type
LRP_NUMBER	C	10	0	LRP Number
LRP_DISPL	N	6	0	Cumulative Chainage to LRP
LRP_DESC	C	50	0	LRP Description
PHOTO_NUM	N	5	0	Digital Photo Number
PHOTO_NAME	C	20	0	Digital Photo Name (Camera Specific)
TIME	C	8	0	Time of Observation
LATITUDE	C	20	0	Latitude
LONGITUDE	C	20	0	Longitude
ALTITUDE	N	7	2	Altitude
OFFSET	N	5	1	Offset of LRP From Vehicle
RQxxxxxx.DBF – Moving Traffic Survey Processed				
START_TIME	N	5	2	Time of ADT Interval Start
END_TIME	N	5	2	Time of ADT Interval End
SURV_DUR	N	8		Survey Duration (s)
VEHICLE	C	40		Vehicle Description
EVENT	C	8		Event Key Pressed
REL_SPEED	N	3		Relative Speed (km/h)
COUNT	N	8		Number of Vehicles Observed
DIRECTION	N	1		Direction
ADT	N	8		ADT (vehicles)
AADT	N	8		AADT (vehicles)
CF_ADT	N	6	2	ADT Correction Factor
CF_AADT	N	6	2	AADT Correction Factor

© 2001 Data Collection Ltd.

ROxxxxxx.DBF – Moving Traffic Survey Raw Data				
RECTYPE	C	2		Record Type
C_TIME	N	8		Cumulative Survey Time (s)
C_CHAINAGE	N	8		Cumulative Survey Chainage (m)
VEHICLE	C	40		Vehicle Description
EVENT	C	8		Event Key Pressed
DIRECTION	N	1		Direction Vehicle Travelled In
REL_SPEED	N	3		Relative Speed (km/h)
RRxxxxxx.DBF - Roughness				
RECTYPE	C	2		Record Type
CHAINAGE	C	10		Current Chainage
LRP_NUMBER	C	5		Current LRP
ROUGH_1	N	8	0	BI #1 Roughness in counts/sampling interval
ROUGH_2	N	8	0	BI #2 Roughness in counts/sampling interval
SPEED	N	8	0	Average Speed in km/h
COMMENT	C	64		Comment
RSxxxxxx.DBF - SpeedProfile				
CHAINAGE	N	8	1	Current Chainage
TIME	N	8	2	Current Time
C_CHAINAGE	N	8	1	Cumulative Chainage
C_TIME	N	8	2	Cumulative Time
D_CHAINAGE	N	8	1	Incremental Chainage
D_TIME	N	8	2	Incremental Time
AVG_SPEED	N	8	1	Average Speed in km/h
INST_SPEED	N	8	1	Instantaneous Speed in km/h
INST_ACCEL	N	8	2	Instantaneous Acceleration in m/s/s
LRP_NUMBER	C	5		Current LRP
COMMENT	C	64		Comment
RTxxxxxx.DBF - Speed Survey				
RECTYPE	C	2		Record Type
CHAINAGE	C	8		Current Chainage
C_CHAINAGE	C	8		Cumulative Chainage
TIME	N	8	2	Current Time
C_TIME	N	10	2	Cumulative Time
LRP_NUMBER	C	5		Current LRP
COMMENT	C	64		Comment
RXxxxxxx.DBF - Gyroscope Data				
TIME	N	8	1	Time of Measurement in s
PITCH	N	5	1	Vehicle Pitch in degrees
ROLL	N	5	1	Vehicle Roll in degrees
AZIMUTH	N	5	1	Vehicle Azimuth in degrees

RZxxxxxx.DBF - Elevation Profile				
CHAINAGE	N	5	1	Chainage of Placement
ELEVATION	N	7	1	Elevation of Placement

Note: *If using the ROMDAS profiler there will be additional fields containing internal data*

© 2001 Data Collection Ltd.

RVxxxxxx.DBF - Transverse Profile Raw Data RWxxxxxx.DBF - Transverse Profile Corrected and Standardised Data RAxxxxxx.DBF - Transverse Profile Single Measurement Data RBxxxxxx - Transverse Profile Multiple Measurement Data CTxxxxxx.DBF - Transverse Profile Datum Level File				
DESCRIPTIO	C	64		Description
DATE	D	8		Date of Survey
VEHICLE	C	20		Vehicle ID
OPERATOR	C	30		Operator ID
CHAINAGE	C	8		Current Chainage
LRP_NUMBER	C	5		Current LRP
SLOPE	N	5	1	Slope of Distance Calibration Equation
CONSTANT	N	5	1	Constant of Distance Calibration Equation
STAN_DIST	N	5	1	Standard Distance During the Survey
STAN_SENSR	N	2	0	Sensor Used for Standard Distance
ELEV_1	N	5	2	Elevation of Sensor 1
ELEV_2	N	5	2	Elevation of Sensor 2
ELEV_3	N	5	2	Elevation of Sensor 3
ELEV_4	N	5	2	Elevation of Sensor 4
ELEV_5	N	5	2	Elevation of Sensor 5
ELEV_6	N	5	2	Elevation of Sensor 6
ELEV_7	N	5	2	Elevation of Sensor 7
ELEV_8	N	5	2	Elevation of Sensor 8
ELEV_9	N	5	2	Elevation of Sensor 9
ELEV_10	N	5	2	Elevation of Sensor 10
ELEV_11	N	5	2	Elevation of Sensor 11
ELEV_12	N	5	2	Elevation of Sensor 12
ELEV_13	N	5	2	Elevation of Sensor 13
ELEV_14	N	5	2	Elevation of Sensor 14
ELEV_15	N	5	2	Elevation of Sensor 15
ELEV_16	N	5	2	Elevation of Sensor 16
ELEV_17	N	5	2	Elevation of Sensor 17
ELEV_18	N	5	2	Elevation of Sensor 18
ELEV_19	N	5	2	Elevation of Sensor 19
ELEV_20	N	5	2	Elevation of Sensor 20
ELEV_21	N	5	2	Elevation of Sensor 21
ELEV_22	N	5	2	Elevation of Sensor 22
ELEV_23	N	5	2	Elevation of Sensor 23
ELEV_24	N	5	2	Elevation of Sensor 24
ELEV_25	N	5	2	Elevation of Sensor 25
ELEV_26	N	5	2	Elevation of Sensor 26
ELEV_27	N	5	2	Elevation of Sensor 27
ELEV_28	N	5	2	Elevation of Sensor 28
ELEV_29	N	5	2	Elevation of Sensor 29
ELEV_30	N	5	2	Elevation of Sensor 30
ELEV_31	N	5	1	Elevation of Fixed Sensor
XF_METHOD	N	1	0	Crossfall Method
ROLL	N	5	2	Vehicle Roll in Degrees
BAR_ROAD	N	5	2	Angle of Vehicle to Road in Degrees
CROSSFALL	N	5	2	Crossfall in Degrees
XF_STAT	N	5	1	Croassfall Statistic

© 2001 Data Collection Ltd.

ANNEX N STEP BY STEP INSTRUCTIONS

This annex contains a series of 'step by step' instructions on how to install the system and to conduct the various surveys outlined in this manual. The objective is to show the recommended series of actions which should be taken in setting up the ROMDAS software, testing the system, and running LRP, roughness and keycode surveys. In the descriptions which follows the names in bold capitals are the ROMDAS menus – for example **SETUP|OPTIONS|PROGRAM SETTINGS**.

ANNEX O contains a series of 'problem solving' instructions to follow in the event of difficulties.

INSTALLING THE HARDWARE

1. Read Chapter 3.
2. Locate the dedicated ROMDAS battery in a suitable location. It should be firmly fixed to the vehicle so that it cannot move about.
3. Connect the BROWN wire from the ROMDAS Power Switch to the Positive (+) terminal; the BLUE wire to the Negative (-) terminal.
4. Use the multimeter supplied with the ROMDAS to ensure that there is +12 volts from the power switch:
   (a) Turn the dial on the multimeter to 15 DC
   (b) Turn on the ROMDAS power switch. The red light should come on.
   (c) Insert the multimeter + sensor in the centre of the power switch plug; the - sensor on the outside of the plug. The meter should read approximately +12 volts.
   (d) Turn off the power switch. The red light should no longer be on.
4. Install the speedometer sensor according to the instructions in ANNEX E.
5. Install the roughness meter (optional) according to the manufacturers instructions (See Annex F). If it is **not** a ROMDAS or Farnell Bump Integrator ensure that the connections are as described in ANNEX D.
6. If necessary, connect the reverse light switch (See Chapter 3).
7. Determine where the hardware interface will be located. The location will be governed by factors such as the type of vehicle and length of cables. The recommended location is under the front seat.
8. Run the cables from the power, odometer, roughness meter and reverse switch to the hardware interface, preferably under the vehicle carpet or mats.
9. TURN THE VEHICLE AND ITS POWER OFF.
10. Locate the power switch in an accessible location.
11. Connect the cables to the appropriate sockets on the hardware interface. (See Chapter 3).
12. Turn the power on. The red light should be on with both the power switch and the light next to the power socket on the hardware interface should be on.
13. Plug in the RS-232 cable to the computer and the hardware interface.
14. The light next to the RS-232 port should be flashing once the ROMDAS software has started. If not, turn the power on and off and restart the ROMDAS software.

SETTING UP THE ROMDAS SOFTWARE

1. Install the software on your computer from the master disk by inserting the disk into the floppy disk drive and typing GO. Define the directory for the software to be installed into. See Chapter 3 for more details.
2. Change to the ROMDAS directory.
3. Type in TEST to start the software. This issues the command ROMDAS /T.

© 2001 Data Collection Ltd.

4. The first time the software is started you will need to enter your serial number. This is on the main ROMDAS disk.
5. From the ROMDAS main menu select the **SETUP|CUSTOMISE** menu.
6. Select **DEFAULT FILE DIRECTORY** and select the directory you would like to store the survey data in (usually the default ROMDAS directory).
7. Select **SCREEN COLOURS** and define the screen colour.
8. If you would like to change the pause key from the SPACE bar or use a mouse define these under the **SETUP|CUSTOMISE** menu.
9. Press ESC and select **SETUP|OPTIONS**.
10. Type in the password **ROMDAS**.
11. Select **PROGRAM SETTINGS** and enter the ROMDAS hardware version number. If you have a box with 2 x DIN connectors on the side and have the ROMDAS BI and/or the ROMDAS high resolution DMI it is v 4; if you have a non-ROMDAS BI it is v 3; if you have a silver box with a 25 pin socket on the end it is v 2.
12. Select **COMM PORT** and enter the communication port number(s). ROMDAS is usually installed on COMM 1.
13. Select **USER NAME** and enter the name of the licencee (who you are!)
14. Select **PASSWORD** and change the options password from ROMDAS to something else. This is optional. **REMEMBER THE NEW PASSWORD**.

There are a number of specific survey options available under the **SETUP|OPTIONS** menus. These should be selected after reviewing Chapter 5 of the manual. The default settings have been selected as appropriate for most typical applications.

PREPARING FOR SURVEYS

To prepare for surveys the following steps should be taken.

1. Assign each road to be surveyed a unique identification and description.
2. If you would like to have additional data stored, for example the name of a Divison/District there are three user-definable fields that can be used. These are located under **SETUP|CUSTOMISE|USER DEFINED FIELDS**.
3. From the main menu select **SETUP|EDIT DATA FILES|EDIT ROAD DEFINITION DATA**.
4. OPTIONALLY: Type in the data for each road to be surveyed into the appropriate fields, including the user defined data. During a survey when the Road ID is entered these data will be used (see Chapter 5). This has the advantage of controlling the data used in surveys. If you have a road management system you can use the management system output to define the data in this file.
5. Select **SETUP|EDIT DATA FILES|EDIT KEYCODE EVENT FILE**.
6. Define the events to be associated with each key during keyboard rating.
7. If you will be defining LRPs do this under **SETUP|EDIT DATA FILES|EDIT LRP DEFINITION DATA.** This provides a short cut to typing in LRP names.

ODOMETER CALIBRATION

Before any survey is conducted the odometer **MUST** be calibrated. This is done as follows:

1. Ensure that the tyres are balanced and the vehicle is in good condition (springs, shock absorbers, etc.).
2. Select a flat, straight section of road with little traffic.
3. Clearly mark on the pavement the start chainage.
4. Measure at least 200 m with a tape and mark the end chainage.

© 2001 Data Collection Ltd.

5. Drive the vehicle until the tyres are warm (at least 30 minutes) and set the pressure at a standard value.
6. Select **SETUP|CALIBRATE|CALIBRATE ODOMETER|RUN CALIBRATION TEST**.
7. If you are not using a proximity sensor:
   (a) Drive the vehicle and park at the start chainage mark. It is usually convenient to have the mark under the passenger door so that an observer can note its postion.
   (b) Press the SPACE bar to commence recording.
   (c) Drive the vehicle at a slow speed straight along the road.
   (d) Press the SPACE bar at the end of the section.
8. If you are using a 'Proximity Sensor':
   (a) Ensure that the entry under **SETUP|OPTIONS|PROGRAM SETTINGS** for the proximity sensor is set to **Y**.
   (b) Place the start target at the start chainage mark; the end target (if used) at the end chainage mark.
   (c) Enter **Y** when prompted if a proximity sensor is to be used.
   (d) Drive the vehicle at a slow speed straight along the road.
   (e) When the target is encountered the odometer will start recording. It will stop recording when the end target is encountered. If there is no end target, press the SPACE bar at the end mark.
9. At the completion of the test write down the calibration factor displayed.
10. Repeat the calibration at least 3 times, or until the value can be confidently established (see ANNEX J and discussion of measurement accuracy/number of runs in the context of roughness surveys).
11. Enter the final value under **SETUP|CALIBRATE|CALIBRATE ODOMETER|ENTER OWN CALIBRATION FACTOR**.

CALIBRATING ROUGHNESS METER

1. Profile the test sections as described in ANNEX J.
2. Select **SETUP|CALIBRATE|CALIBRATE ROUGHNESS METER.**
3. Enter in the name of the calibration run. Use a name which reflects (a) the test section name and (b) the speed that will be used.
4. Enter the length of the test section. The program will terminate the survey when this distance has been travelled.
5. Press the F10 key to get to the roughness calibration opening screen.
6. Drive the vehicle to the calibration speed in advance of the start of the test section. Press the SPACE bar when passing the test section start point. If a proximity sensor is being used it will operate the same as under the odometer calibration survey.
7. When the test section distance has been travelled the program will stop, displaying the raw count and the average speed. Note these values on paper and then save the data by pressing S.
8. As described in ANNEX J, do a minimum of 5 runs at each speed and calculate the mean roughness and the mean speed (there will be slight variations in speed).
9. Using the NLREG program supplied with ROMDAS, develop calibration equations for each speed (see ANNEX J).
10. Select **SETUP|EDIT DATA FILES|EDIT ROUGHNESS CALIBRATION COEFFICIENTS**.
11. Assign each vehicle a unique identifier and enter the coefficients for the IRI calibration equations.

© 2001 Data Collection Ltd.

TRANSVERSE PROFILE LOGGER - INITIAL SETUP

As described in ANNEX G, before the TPL is used in the field, it is necessary to undertake some preliminary calibration.

1. Decide upon what the 'Standard Conditions' will be for the TPL. These represent a baseline against which all measurements will be standardised. It is recommended that these be determined at a convenient location, for example the depot where the TPL will be operated from. For example, if there is a garage where the temperature can be held constant that will suffice.
2. Set up the TPL at the location with the Standard Conditions.
3. Decide which sensor will be used as the Fixed Target. If you have a version of the TPL with a dedicated fixed sensor this will be sensor 31. If you do not have a dedicated sensor you will need to construct a target and place it at a distance of approximately 250 mm below one of the TPL sensors. It is recommended that this consist of a 50 mm diameter pipe with a plug at one end and holes drilled in it to ensure that the sensor is recording ambient conditions.
4. Select **SETUP|CALIBRATE|CALIBRATE TPL|MULTIPLE MEASUREMENTS**. Take a set of readings and note the value for the fixed target sensor. The average of these values will represent your standard distance.
5. Go to **SETUP|TRANSVERSE PROFILE LOGGER|TPL SETUP**. Enter the value for the standard distance in the box for "Fixed Target Distance at Standard Conditions".
6. The next step is to determine the calibration equation for the TPL. This will require a tape measure and a 500 mm wide square object for a target, such as an "L" shaped plate or a solid block. Place one of the TPL UMS arrays on a bench with the tape measure extending out perpendicular to the sensor in the direction of measurement. Place the object at a distance of 250 mm from the UMS. Ideally, the fixed target sensor should also be connected.
7. Run **SETUP|CALIBRATE|CALIBRATE TPL|MULTIPLE MEASUREMENTS**. Take a set of readings and note the distance to the target for each sensor. Note the value for the fixed target sensor from 3. above as well. Repeat this at 25 mm intervals to a distance of 750 mm. If there are wide variations in the readings adjust the foam protector for the sensor.
8. Adjust each of the measurements for the changes in the standard conditions. This is done by multiplying the measured value by the standard distance, and dividing by the fixed target distance during the measurements.
9. Perform a linear regression on the data and develop an equation between the known distance from the tape measure and the distances from 8.
10. Go to **SETUP|TRANSVERSE PROFILE LOGGER|TPL SETUP.** Enter the values for the slope and the constant of the regression equation.
11. Install all the UMS arrays in the TPL housing.
12. Measure the distances between the sensors on adjacent UMS arrays. This is easiest done by taking the distance from the right (or left) side of the sensor pairs.
13. Go to **SETUP|TRANSVERSE PROFILE LOGGER|TPL SETUP** and enter the values for these distances.

CALIBRATION OF TRANSVERSE PROFILE LOGGER

Before surveys the TPL should be calibrated. This is done as follows.

1. Obtain a straight-edge. If you are only using the main section of the TPL a 2.0 m straight-edge will suffice. A 3.0 m straight-edge is required when using the TPL 'wings'. Alternatively (and preferably) use a trough with water since this will always be level.
2. Place the straight-edge (or calibration level) below the TPL.
3. Ensure that it is parallel with the TPL. This is best achieved by either hanging the TPL under the TPL or by having a series of shims which can be used to raise it

© 2001 Data Collection Ltd.

above the ground. Measure the distance at each end of the straight-edge and ensure that they are identical.
4. Run **SETUP|CALIBRATE|CALIBRATE TPL|MULTIPLE MEASUREMENTS** and take a set of readings.
5. Run **SETUP|CALIBRATE|CALIBRATE TPL|CREATE DATUM LEVEL**. This will create a file with the appropriate relative heights of each sensor. When processing the data, ensure that the calibration file from the day of survey is used.

LOCATION REFERENCE POINT SURVEYS

It is STRONGLY recommended that location reference points (LRPs) be used in all surveys (see Chapter 2). The first survey that should be done is an LRP survey. You will more than recoup the investment in time and effort from doing this. LRP surveys are done as follows:

1. Ensure that the tyres are balanced and the vehicle is in good condition (springs, shock absorbers, etc.).
2. Warm up the tyres (min 30 minutes driving) and check that they are at the same standard pressure used in the odometer calibration.
3. Ensure that the appropriate supporting files are on the computer:
   - ROADDAT.DBF - File names, LRP option, etc.
   - LRP_DEF - LRP definition file
   - KEYBOARD.DBF - Keyboard Rating data
4. Select **LOCATION REFERENCE POINT SURVEY** from the main menu.
5. Enter the ROAD ID. This should correspond to a value in the ROADDAT.DBF file if the latter is used.
6. If the data are not supplied from the ROADDAT.DBF, enter in the Road Description and any user defined data. These data will be filed in ROADDAT.DBF for future surveys when the same ROAD ID is used.
7. Define the use of LRP files:
   - Y - use an existing LRP file;
   - D - define an LRP file during the roughness survey;
   - N - do not use an LRP file.
8. Enter the Initial Chainage. If you are starting at the beginning of the road, set this value to 0, otherwise the actual chainage.
9. Enter the Start Chainage. This is the chainage where the survey commences. It must be greater than or equal to the Initial Chainage. It will usually be 0.
10. If you are going in an increasing chainage (200, 300, 400 etc.) enter I for Increment; otherwise enter D for decrement.
11. Press F10 to commence the survey.
12. At the opening screen type in the start LRP name. Position the vehicle at this point and press the SPACE bar to start recording.
13. Drive the vehicle straight along the road.
14. When you approach an LRP slow down and, if possible, stop at the LRP.
15. Press the ESC key and enter a description of the LRP.
16. Repeat 13. - 15. until the road has been surveyed.
17. Press F10 and S to save the data.

ROUGHNESS SURVEYS

Before commencing a roughness survey it is recommended that a location reference point (LPR) survey be conducted. This will define the LRPs which are then used in the roughness survey. LRP surveys were described above.

1. Ensure that the tyres are balanced and the vehicle is in good condition (springs, shock absorbers, etc.).

© 2001 Data Collection Ltd.

2. Check that you have spares with you (roughness meter wire, fuses, etc.).
3. Warm up the tyres (min 30 minutes driving) and check that they are at the same standard pressure used in the odometer calibration.
4. Ensure that the appropriate supporting files are on the computer:
   - ROADDAT.DBF - File names, LRP option, etc.
   - KEYBOARD.DBF - Keyboard Rating data
5. Select **ROAD ROUGHNESS SURVEY** from the main menu.
6. Enter the ROAD ID. This should correspond to a value in the ROADDAT.DBF file if the latter is used.
7. If the data are not supplied from the ROADDAT.DBF, enter in the Road Description and any user defined data. These data will be filed in ROADDAT.DBF for future surveys when the same ROAD ID is used.
8. Define the use of LRP files:
   - Y - use an existing LRP file;
   - D - define an LRP file during the roughness survey;
   - N - do not use an LRP file.
9. Enter the Initial Chainage. If you are starting at the beginning of the road, set this value to 0, otherwise the actual chainage.
10. Enter the Start Chainage. This is the chainage where the survey commences. It must be greater than or equal to the Initial Chainage. It will usually be 0.
11. If you are going in an increasing chainage (200, 300, 400 etc.) enter I for Increment; otherwise enter D for decrement.
12. If you know the length of the road that will be surveyed, and only want to measure this length, enter a value for 'Length'. To have the survey automatically stop at this chainage the option must be specified under **SETUP|OPTIONS|PROGRAM SETTINGS.**
13. Enter the Sampling Interval. This is the length of road (in m) to sum the roughness over.
14. If you are using a Transverse Profile Logger enter Y in the TPL Measurement box, and the interval to make the measurements at.
15. Once all these data are entered, press F10 to continue. Position the vehicle and press the SPACE bar to start the survey.
16. The survey can be paused, intermediate roughnesses recorded, and the roughness meter halted by pressing the appropriate keys. In addition, keyboard rating can be done using any of the keys which have been defined.
17. At LRPs, press the ESC key.
18. At the end of the survey press the F10 key and:
    - S - to save the data
    - A - to abandon the data
    - O - to measure the other side of the road (see Chapter 2)
    - N - to do another survey

TRAVEL TIME AND CONGESTION SURVEYS

Before commencing a travel time survey it is recommended that a location reference point (LPR) survey be conducted. This will define the LRPs which are then used in the roughness survey. LRP surveys were described above. It is also necessary to define the file KEYCODE.DBF. This was also described above under setting up the software.

1. Ensure that the tyres are balanced and the vehicle is in good condition (springs, shock absorbers, etc.).
2. Check that you have spares with you (roughness meter wire, fuses, etc.).
3. Warm up the tyres (min 30 minutes driving) and check that they are at the same standard pressure used in the odometer calibration.
4. Ensure that the appropriate supporting files are on the computer:
   - ROADDAT.DBF - File names, LRP option, etc.
   - KEYBOARD.DBF - Keyboard Rating data

© 2001 Data Collection Ltd.

5. Select **TRAVEL TIME & CONGESTION SURVEY** from the main menu.
6. Enter the ROAD ID. This should correspond to a value in the ROADDAT.DBF file if the latter is used.
7. If the data are not supplied from the ROADDAT.DBF, enter in the Road Description and any user defined data. These data will be filed in ROADDAT.DBF for future surveys when the same ROAD ID is used.
8. Define the use of LRP files:
   - Y - use an existing LRP file;
   - N - do not use an LRP file.
9. Enter the Initial Chainage. If you are starting at the beginning of the road, set this value to 0, otherwise the actual chainage.
10. Enter the Start Chainage. This is the chainage where the survey commences. It must be greater than or equal to the Initial Chainage. It will usually be 0.
11. If you are going in an increasing chainage (200, 300, 400 etc.) enter I for Increment; otherwise enter D for decrement.
12. Once all these data are entered, press F10 to continue. Position the vehicle and press the SPACE bar to start the survey.
13. Enter any data using the appropriately defined keycodes. It is recommended that the keys be labelled with the appropriate values.
14. At LRPs, press the ESC key.
15. At the end of the survey press the F10 key and:
    - S - to save the data
    - A - to abandon the data
    - O - to measure the other side of the road (see Chapter 2)
    - N - to do another survey

KEYCODE SURVEYS

Before commencing a keycode survey it is recommended that a location reference point (LPR) survey be conducted. This will define the LRPs which are then used in the roughness survey. LRP surveys were described above. It is also necessary to define the file KEYCODE.DBF. This was also described above under setting up the software..

1. Ensure that the tyres are balanced and the vehicle is in good condition (springs, shock absorbers, etc.).
2. Check that you have spares with you (roughness meter wire, fuses, etc.).
3. Warm up the tyres (min 30 minutes driving) and check that they are at the same standard pressure used in the odometer calibration.
4. Ensure that the appropriate supporting files are on the computer:
   - ROADDAT.DBF - File names, LRP option, etc.
   - KEYBOARD.DBF - Keyboard Rating data
5. Select **KEYBOARD RATING SURVEY** from the main menu.
6. Enter the ROAD ID. This should correspond to a value in the ROADDAT.DBF file if the latter is used.
7. If the data are not supplied from the ROADDAT.DBF, enter in the Road Description and any user defined data. These data will be filed in ROADDAT.DBF for future surveys when the same ROAD ID is used.
8. Define the use of LRP files:
   - Y - use an existing LRP file;
   - N - do not use an LRP file.
9. Enter the Initial Chainage. If you are starting at the beginning of the road, set this value to 0, otherwise the actual chainage.
10. Enter the Start Chainage. This is the chainage where the survey commences. It must be greater than or equal to the Initial Chainage. It will usually be 0.
11. If you are going in an increasing chainage (200, 300, 400 etc.) enter I for Increment; otherwise enter D for decrement.

© 2001 Data Collection Ltd.

12. Once all these data are entered, press F10 to continue. Position the vehicle and press the SPACE bar to start the survey.
13. Enter any data using the appropriately defined keycodes. It is recommended that the keys be labelled with the appropriate values.
14. At LRPs, press the ESC key.
15. At the end of the survey press the F10 key and:
    - S - to save the data
    - A - to abandon the data
    - O - to measure the other side of the road (see Chapter 2)
    - N - to do another survey

© 2001 Data Collection Ltd.

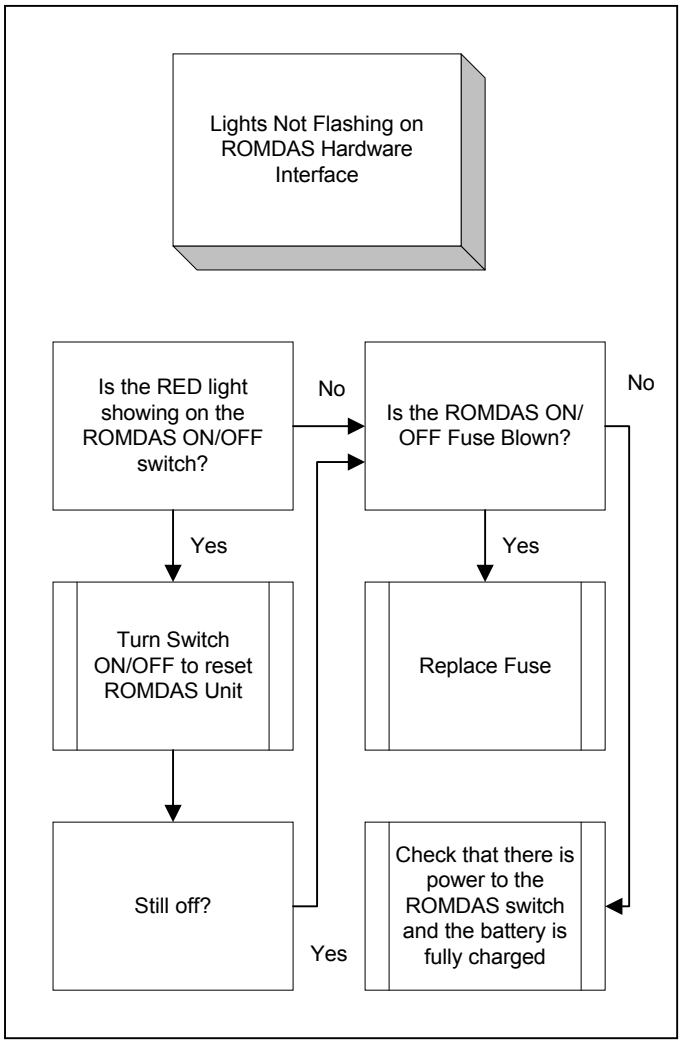
ANNEX O PROBLEM SOLVING WITH ROMDAS

There are three types of problems encountered with ROMDAS:

- **Software Conflict**. There is a conflict between the ROMDAS software and an application on the PC.
- **Hardware Failure**. There is a problem with the ROMDAS hardware or a connection.
- **Software Bug.** Yes, it happens. With ROMDAS being over 11,000 lines of complicated code, bugs are an unfortunate fact of life. Just ask Microsoft®.

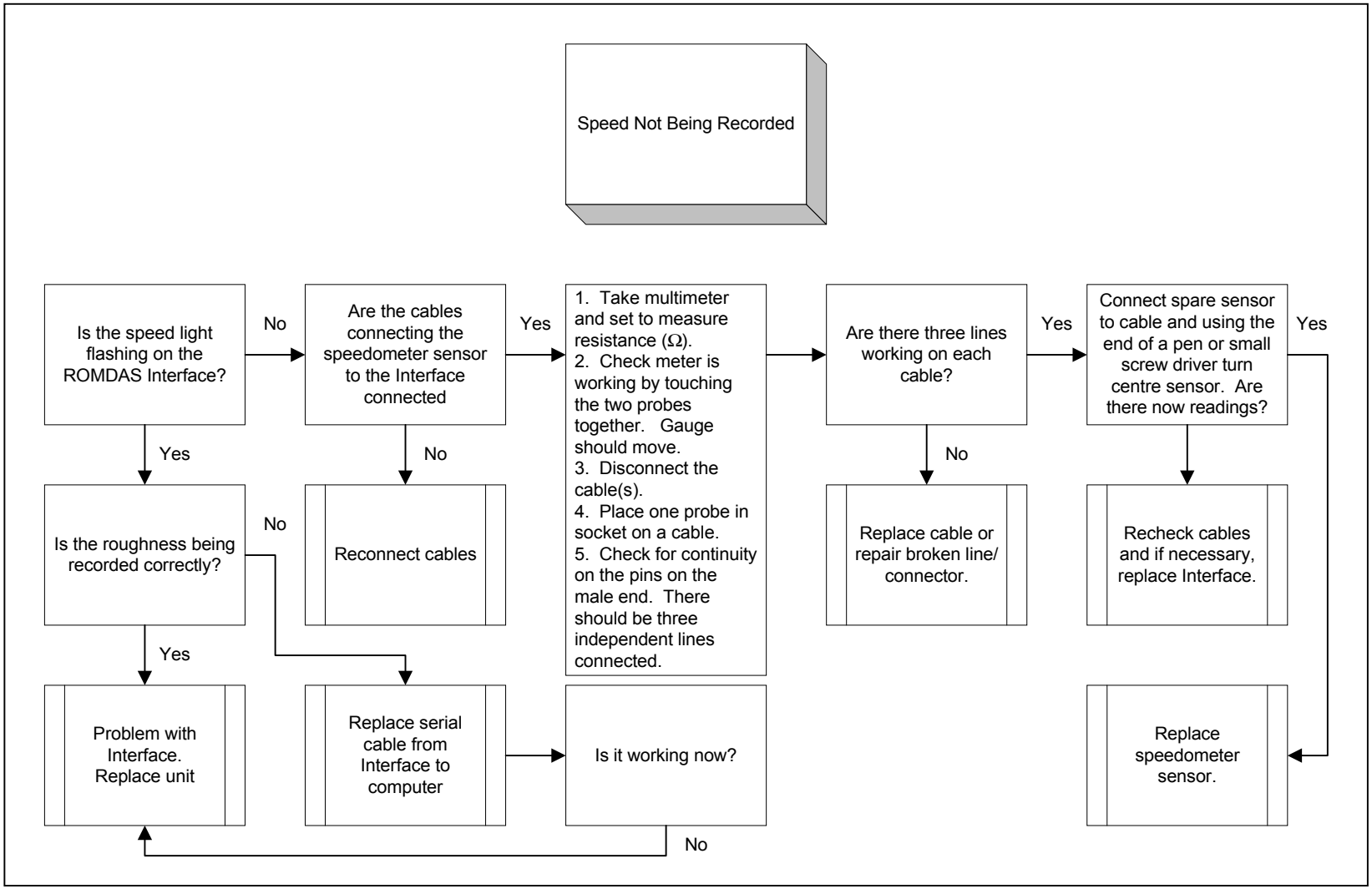
1. Read the section in Chapter 3 of this manual entitled "If Something Goes Wrong" and follow the instructions there. That usually solves it.
2. Most problems are due to a connection coming loose with the hardware. The easiest way of checking the system is to use the **SETUP|CALIBRATION|CALIBRATE ODOMETER.** This shows the pulses coming from the system and is used as follows:
   - Turn off/on the ROMDAS interface.
   - Start the calibration.
   - If the number of odometer pulses increases you know that the interface is working fine. If you get a message like CR_FRZSTOR or something similar then you know that the PC is not talking to the interface. If that is the case FIRST CHECK TO MAKE SURE THAT NO DRIVERS OR PROGRAMS ARE LOADED WITH ROMDAS. That solves 99% of the problems. If that doesn't work follow the instructions below.
3. The problems are noted either by the lights on the hardware Interface not flashing or the ROMDAS display giving bad data:
   - If the lights are not flashing, follow the guidelines on the following flowchart to correct.
   - If the roughness values are zero or very low, check the roughness meter using the guidelines on the flow chart.
   - If the speed is too low ROMDAS will give a warning that the vehicle is below its minimum speed. Check the speedometer sensor using the guidelines on the flow chart.
   - If the speeds are too high or are significantly different to the values displayed on the vehicle speedometer, check the speedometer calibration factor.
4. If the software displays a communications error the problem is usually due to:
   - Is the ROMDAS turned on?
   - Check that the serial cable is firmly connected to the computer.
   - Reset the ROMDAS Interface by switching it on and off.
   - There may be insufficient power to the Interface from the battery.
   - It may be necessary to reset the ROMDAS software by exiting and starting again, particularly if you are running under Windows.
5. If you are using the vehicle electrical system to power the inverters or elements of the ROMDAS system ensure that they are providing sufficient power and that the fuse is not blown.

© 2001 Data Collection Ltd.


Lights Not Flashing on ROMDAS Hardware Interface
Is the RED light showing on the ROMDAS ON/OFF switch?
No
Is the ROMDAS ON/ OFF Fuse Blown?
No
Yes
Yes
Turn Switch ON/OFF to reset ROMDAS Unit
Replace Fuse
Still off?
Yes
Check that there is power to the ROMDAS switch and the battery is fully charged

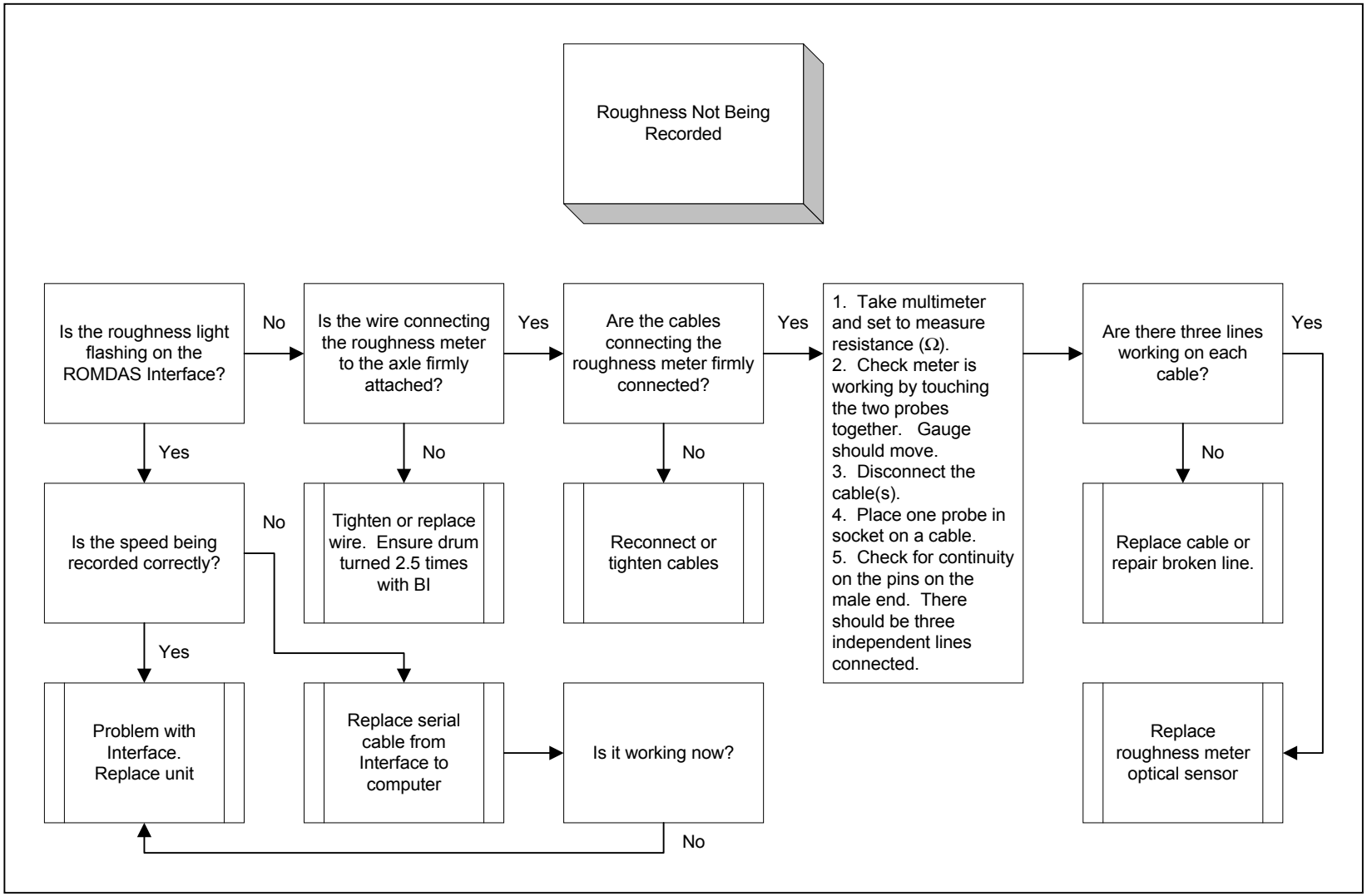
Flow Chart 1: No Lights on ROMDAS Hardware Interface

© 2001 Data Collection Ltd.


Speed Not Being Recorded
Is the speed light flashing on the ROMDAS Interface?
No
Are the cables connecting the speedometer sensor to the Interface connected
Yes
1. Take multimeter and set to measure resistance (Ω).
2. Check meter is working by touching the two probes together. Gauge should move.
3. Disconnect the cable(s).
4. Place one probe in socket on a cable.
5. Check for continuity on the pins on the male end. There should be three independent lines connected.
Are there three lines working on each cable?
Yes
Connect spare sensor to cable and using the end of a pen or small screw driver turn centre sensor. Are there now readings?
Yes
Yes
No
No
Is the roughness being recorded correctly?
No
Reconnect cables
Replace cable or repair broken line/ connector.
Recheck cables and if necessary, replace Interface.
Yes
Problem with Interface. Replace unit
Replace serial cable from Interface to computer
Is it working now?
Replace speedometer sensor.
No

Flow Chart 2: Speed Not Recorded

© 2001 Data Collection Ltd.


Roughness Not Being Recorded
Is the roughness light flashing on the ROMDAS Interface?
No
Is the wire connecting the roughness meter to the axle firmly attached?
Yes
Are the cables connecting the roughness meter firmly connected?
Yes
1. Take multimeter and set to measure resistance (Ω).
2. Check meter is working by touching the two probes together. Gauge should move.
3. Disconnect the cable(s).
4. Place one probe in socket on a cable.
5. Check for continuity on the pins on the male end. There should be three independent lines connected.
Are there three lines working on each cable?
Yes
Yes
No
No
No
Is the speed being recorded correctly?
No
Tighten or replace wire. Ensure drum turned 2.5 times with BI
Reconnect or tighten cables
Replace cable or repair broken line.
Yes
Problem with Interface. Replace unit
Replace serial cable from Interface to computer
Is it working now?
Replace roughness meter optical sensor
No

Flow Chart 3: Roughness Not Recorded

© 2001 Data Collection Ltd.

ANNEX P COMPUTER COMPATIBILITY ISSUES

Computers Reported To Work With ROMDAS

ROMDAS has been tested and used on a number of different notebook computers. The following table lists the models which it has been reported to work on.

Make	Model	Procesor	Operating System	Comments
Toshiba	1600	286	DOS	
Toshiba	1910	486SX	Win 3.1	
Toshiba	2110CS	486	Win 95	Not suitable for video
Toshiba	Libretto 20	486-75	Win 95	
Toshiba	100CDT/CDS	P-100	Win 95	
Toshiba	110CDT	P-100	Win 95	
Toshiba	400 CDT	P-100	Win 95	
Toshiba	430CDT	P-133	Win 95	
Toshiba	480 CDT	P-266	Win 95	
Toshiba	Tecra 500CDT	P-100	Win 95	
Toshiba	Tecra 520CDT	P-266	Win 95	
Toshiba	Tecra 550 CDT	P-266	Win 95	Not suitable for video
Toshiba	Tecra 720CDT	P-133	Win 95	Not suitable for video
Toshiba	Tecra 740CDM	P-233	Win 95	Not suitable for video
Toshiba	4000CDT	P-233	Win 95	
Toshiba	4100CDT	P-233	Win 95	
Digital	Hi Note VP700	P-233	Win 95	Best run as DOS box in Win95 instead of shutting down to DOS
Hitachi		P-266	Win 95	Had to reset the default ROMDAS COM port interrupt from 4 to 3
IBM	Thinkpad 360		DOS	Did not support dual display for video
IBM	Thinkpad 360C		Win 95	
IBM	Thinkpad 600		Win 95	Need to ensure COM port works under DOS by changing setup
NEC	Versa	486		

If You Computer Does Not Work

Most computer problems are due to the power management function turning off the COM port. This is usually solved by altering the computer setup. An alternative is to create a bootable floppy disk and start the computer from that. This is done by inserting the floppy disk and from DOS typing the command FORMAT A: /S.

Solving Memory Problems

On some computers users have reported problems with having sufficient memory to run ROMDAS. This usually arises when it is an older machine and they are using three or more instruments (*e.g.* roughness, TPL and GPS). In order to communicate with these additional instruments it is usually necessary to have one or more PCMCIA serial cards, each of which reduces the amount of memory available to ROMDAS. Also, some older PCMCIA cards do not have drivers for Windows 95.

A variety of solutions have been found to these problems; not all work with each system.

© 2001 Data Collection Ltd.

The first thing to try is to run the software as a DOS box under Windows. This is done by selecting the MS-DOS item from the Windows START button. This works because instead of using DOS memory managers it uses Windows—as long as the memory variables in the DOS window properties are set to AUTO.

If the problem persists it will be necessary to modify how the system operates under DOS. It is best to create a boot window (see ANNEX S) which will let you boot to MS-DOS.

Firstly, create a swap file for Clipper. This is done by putting the following command into the AUTOEXEC.BAT file:

```
SET CLIPPER= //SWAPK:65535
```

The CONFIG.SYS file should then be modified to include the following commands:

```
DEVICE=HIMEM.SYS
DEVICE=EMM386.EXE RAM
DOS=HIGH,UMB
```

Details on the meaning of these commands can be found in the MS-DOS manual or the online help file. The commands MUST be executed in the above order and with the above switches (*i.e.* do not use the NOEMS switch with EMM386.EXE).

If you still have problems please contact support@romdas.com for further assistance. In these circumstances it is often easiest to courier us your computer and cards and we will get the system working.

Reported Compatibility Issues and Problems

Computers with AMD K6 Chips

ROMDAS has not been able to work on computers using the AMD K6 chip. There are known compatibility problems at the DOS level with these chips and a number of applications and it appears to be due to the AMD chip using a subset of the DOS bios calls.

To get around this problem it is necessary to use a PCMCIA serial card which has been reported to work in several instances.

Windows 98 on Toshiba Notebooks

Problems have been reported with Toshiba notebooks running Windows 98. If you shut down to DOS and use the TSETUP utility you will see that the utility says that the COM port is "not used". This is caused by the Windows 98 power management subsystem deactivating the serial port when restarting in MS-DOS mode. Since the DOS based driver is not able to "wake or reactivate" the serial port, no serial device will work.

The issue only appears to occur on systems that have an ACPI BIOS and Windows 98. There are two solutions:

(a) Boot your computer from a floppy disk. In testing this has solved the problem.
(b) A permanent solution requires modifying the registry as follows.

WARNING: Using the Registry Editor incorrectly can cause serious problems that may require you to reinstall your operating system.

© 2001 Data Collection Ltd.

For information about how to edit the registry, view the "Changing Keys And Values" Help topic in Registry Editor (Regedit.exe) or the "Add and Delete Information in the Registry" and "Edit Registry Data" Help topics in Regedt32.exe.

NOTE: You should back up the registry before you edit it.

1. Boot into Windows 98.
2. Go to the "START" menu, click on "RUN".
3. Enter "REGEDIT.EXE" and click on "OK" to continue.
4. Go to the following registry key:
"Hkey_Local_Machine\System\CurrentControlSet\Services\VxD\VCOMM"
5. Change the value of the "EnablePowerManagement" key from
"01 00 00 00" to "00 00 00 00".
6. Exit registry and restart system.

By making this change, the computer's COM port power management is disabled.

© 2001 Data Collection Ltd.

ANNEX Q ROMDAS CIRCUIT DIAGRAM

To obtain a copy of the ROMDAS circuit diagram please contact info@romdas.com. This is made available to registered users under certain circumstances to assist with local repairs. Our experience has been that it is best for users to return the ROMDAS unit to us for servicing since that is invariably the quickest way for getting a unit working again.

© 2001 Data Collection Ltd.

ANNEX R PCMCIA SERIAL CARDS

When using PCMCIA serial cards it is recommended that the computer be set up to have a boot menu which loads the PCMCIA card driver. ANNEX S (page 274) describes how this is done.

Note: If your computer has power management features enabled and goes into 'hibernation' mode the PCMCIA serial card will be disabled. It is necessary to reboot the machine instead of restoring it.

The discussion below is based on the cards tested by DCL and is not meant to be exhaustive.

SOCKET PCMCIA SERIAL CARDS

The Socket IO Dual PCMCIA card can be run using an 'enabler' which is run from the MS-DOS command prompt or by loading it as a driver in the CONFIG.SYS file. It has been found that the DOS enabler does not work properly with the versions of the card from late-2000 so it is recommended that they be run loaded as drivers from the CONFIG.SYS file.

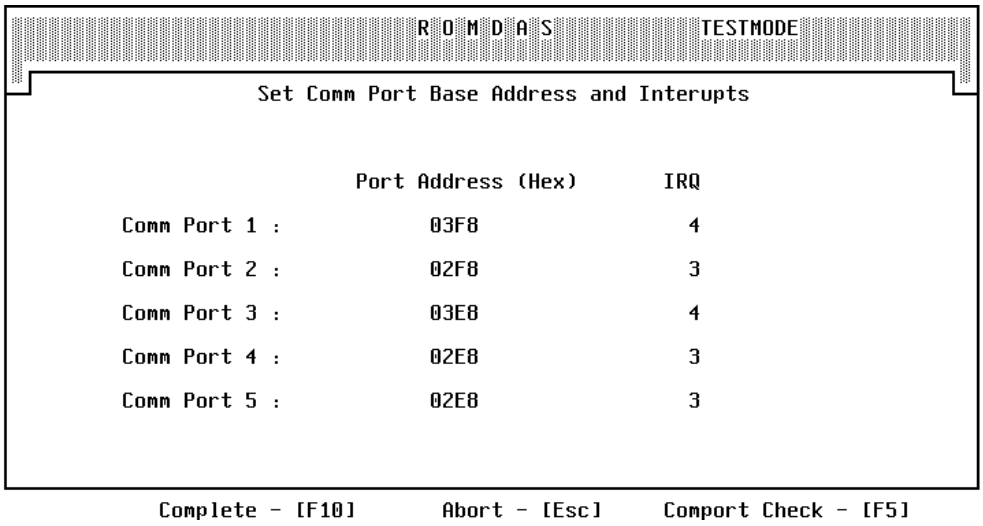
Ruggedised Dual Serial Card – Post 2000

1. Copy the Socket IO DOS enablers to the directory RS232DOS by inserting the Socket IO disk to the A: and from the DOS prompt typing the command **Copy a:\enablers*.* c:\rs232dos**.
2. Open an MS-DOS window and then type EDIT C:\CONFIG.SYS. This will open the config.sys file for editing.
3. Enter the following command at the end of the file which will start the dual IO card on booting:

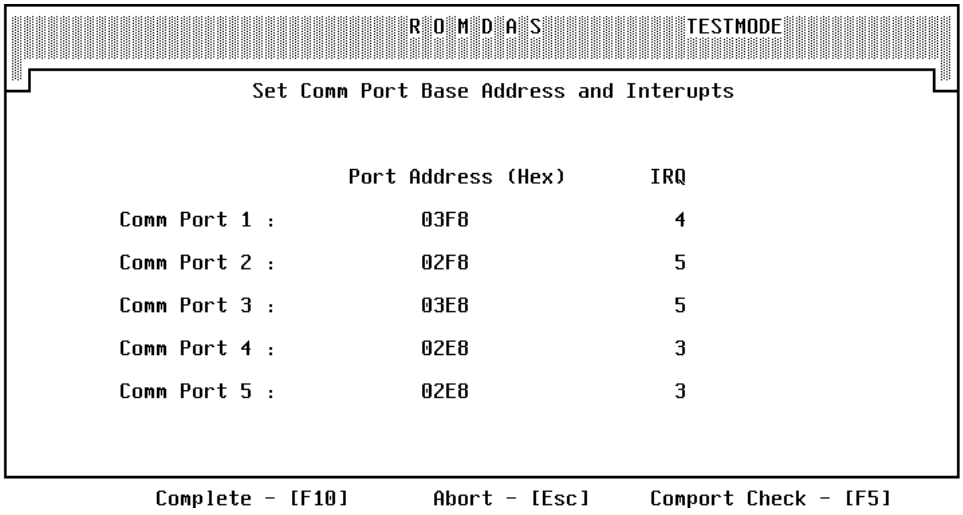
```
device=c:\rs232dos\enabledo.exe com = 2 aux = 3 ireq =5
device=c:\windows\emm386.exe ram
```

4. Insert the dual IO card in the bottom slot (socket 0) and reboot the machine. The message "Card is initialized as COM2 and as COM3 Socket DIO enabled" should be on the screen.
5. At this point it is necessary to set the ROMDAS software to locate the necessary cards. Select **SETUP|OPTIONS|COMM PORT AND PRINTING|ADVANCED COMM PORT SETTINGS.** Pressing the F5 key will show the ports currently installed. The default screen will be as shown below:

© 2001 Data Collection Ltd.


R O M D A S TESTMODE
Set Comm Port Base Address and Interupts
Port Address (Hex) IRQ
Comm Port 1 : 03F8 4
Comm Port 2 : 02F8 3
Comm Port 3 : 03E8 4
Comm Port 4 : 02E8 3
Comm Port 5 : 02E8 3
Complete - [F10] Abort - [Esc] Comport Check - [F5]

6. Press the F5 key and this will show the port address and the interrupts actually in use. Change the address and IRQ values so that they are the same as that shown (see below).


R O M D A S TESTMODE
Set Comm Port Base Address and Interupts
Port Address (Hex) IRQ
Comm Port 1 : 03F8 4
Comm Port 2 : 02F8 5
Comm Port 3 : 03E8 5
Comm Port 4 : 02E8 3
Comm Port 5 : 02E8 3
Complete - [F10] Abort - [Esc] Comport Check - [F5]

13. The final step is to set the COM port number

Pre-2000 Socket IO Dual

1. Copy the Socket IO DOS enablers to the directory RS232DOS by inserting the Socket IO disk to the A: and from the DOS prompt typing the command **Copy a:\enablers*.* c:\rs232dos**. The following files should be located in the directory:

ENABLEDO.EXE
SOCKETIO.INI
STARTDIO.BAT

2. Exit to MS-DOS and type CD \RS232DOS.

© 2001 Data Collection Ltd.

3. Type the command EDIT SOCKETIO.INI. This will open the SOCKETIO.INI file for editing. Change the Socket number to 1 and the IREQ number to 5. The file should tbe as follows:

```
[SOCKETDIO]

   Host=PCIC
   Socket = 1
   Com = 2
   Aux = 3
   Ireq = 5
   AuxInt = enabled
   MemBase = 0xD4000
   MemSize = 0x1000
```

4. Save the file and then type EDIT C:\AUTOEXEC.BAT. This will open the autoexec.bat file for editing.
5. Enter the following command at the end of the file which will start the dual IO card on booting:

```
c:\rs232dos\enabledo.exe file=c:\rs232dos\socketio.ini
```

6. Insert the dual IO card in the top slot and reboot the machine. The message "Card is initialized as COM2 and as COM3 Socket DIO enabled" should be on the screen.
7. At this point it is necessary to set the ROMDAS software to locate the necessary cards. As described above under the Post-2000 Dual PCMCIA Serial Card, select **SETUP|OPTIONS|COMM PORT AND PRINTING|ADVANCED COMM PORT SETTINGS** and define the appropriate settings.

Pre-2000 Socket IO Dual and IBM Single PCMCIA Serial Cards at Same Time

The following is the procedure for running a Pre-2000 Socket IO dual and an IBM single PCMCIA cards at the same time to have a total of 3 additional Comm ports available to the computer.

1. Check what the current COM port settings are on the computer. Often, there are internal modems or infrared devices which are assigned to COM ports. This is done by starting ROMDAS and going to **SETUP|OPTIONS|COMM PORT AND PRINTING|ADVANCED COMM PORT SETTINGS.** Pressing the F5 key will show the ports currently installed. If there is more than 1 COM port listed, you must go to the
2. Insert the IBM card in the bottom socket (Socket 0).
3. Insert the IBM disk in the floppy drive and type INSTALL. Specify COM 4 during the installation. This will insert the following line to the CONFIG.SYS file:

```
DEVICE=C:\RS232DOS\PCCOMDOS.SYS COM4 /BEEP /WINBIOS
```

4. Reboot your machine. The computer should recognise COM 4 and beep. If it does not, follow the diagnostic procedures in the IBM manual. This may entail, for example, disabling an internal modem.
5. Copy the Socket IO DOS enablers to the directory RS232DOS by inserting the Socket IO disk to the A: and from the DOS prompt typing the command **Copy a:\enablers*.* c:\rs232dos**. The following files should be located in the directory:

```
ENABLEDO.EXE
SOCKETIO.INI
```


© 2001 Data Collection Ltd.

STARTDIO.BAT

6. Exit to MS-DOS and type CD \RS232DOS.
7. Type the command EDIT SOCKETIO.INI. This will open the SOCKETIO.INI file for editing. Change the Socket number to 1 and the IREQ number to 5. The file should tbe as follows:

```
[SOCKETDIO]

   Host=PCIC
   Socket = 1
   Com = 2
   Aux = 3
   Ireq = 5
   AuxInt = enabled
   MemBase = 0xD4000
   MemSize = 0x1000
```

8. Save the file and then type EDIT C:\AUTOEXEC.BAT. This will open the autoexec.bat file for editing.
9. Enter the following command at the end of the file which will start the dual IO card on booting:

```
c:\rs232dos\enabledo.exe file=c:\rs232dos\socketio.ini
```

10. Insert the dual IO card in the top slot and reboot the machine. The message "Card is initialized as COM2 and as COM3 Socket DIO enabled" should be on the screen.
11. At this point it is necessary to set the ROMDAS software to locate the necessary cards. As described above under the Post-2000 Dual PCMCIA Serial Card, select **SETUP|OPTIONS|COMM PORT AND PRINTING|ADVANCED COMM PORT SETTINGS** and define the appropriate settings.

EIGER AND IBM SINGLE PCMCIA SERIAL CARDS

The IBM and pre-2000 Eiger single serial port PCMCIA cards are identical, only relabelled. The installation procedure is the same for both.

1. Check what the current COM port settings are on the computer. Often, there are internal modems or infrared devices which are assigned to COM ports. This is done by starting ROMDAS and going to **SETUP|OPTIONS|COMM PORT AND PRINTING|ADVANCED COMM PORT SETTINGS.** Pressing the F5 key will show the ports currently installed. If there is more than 1 COM port listed, you must go to the
2. Insert the PCMCIA card in the bottom socket (Socket 0).
3. Insert the PCMCIA card floppy disk in the floppy drive and type INSTALL. Specify COM 4 during the installation. This will insert the following line to the CONFIG.SYS file:

```
DEVICE=C:\RS232DOS\PCCOMDOS.SYS COM4 /BEEP /WINBIOS
```

4. Reboot your machine. The computer should recognise COM 4 and beep. If it does not, follow the diagnostic procedures in the IBM manual. This may entail, for example, disabling an internal modem.

© 2001 Data Collection Ltd.

QUATECH PCMCIA PORT SERIAL CARDS

The QUATECH cards are used to provide 1, 2 or 4 additional COM ports to ROMDAS. The procedure for installation has been developed on a Toshiba 4010CDT computer, but should apply for others as well. There is a general procedure which applies to all cards and then specific procedures for the 1 and 4 port cards. These procedures should be read in conjunction with the QUATECH user's guide and are not meant to replace the guide.

1. Ensure that the PCMCIA cards are set for PCIC compatible mode. This is done using the notebook hardware setup program.
2. Edit the file c:\CONFIG.SYS and put in the line:
   device=c:\windows\emm386.exe NOEMS x=D000-D7FF
   This will exclude the DOS memory area for the enabler.
3. Insert the QUATECH card into the PCMCIA slot. It is best to ensure that there are no other cards installed such as modems.
4. Install the QUATECH software. This will see the program QSP100EN.EXE copied to a directory. It is best to put it into the ROMDAS directory.
5. Start Windows 95 and install the card. You will be prompted for the QUATECH disk to install the necessary driver.
6. Establish which settings the card has been installed to. This is done by going to START/SETTINGS/CONTROL PANEL. Double click on the SYSTEM icon and then select the DEVICE MANAGER tab. Click on PORTS and you will see the QUATECH card listed. This will list the COM port it has been installed to. Highlight this entry and select PROPERTIES. Click on RESOURCES and this will list the interrupt the card has been assigned to. As a general rule, if there is no modem it will be COM2 and Interrupt 3. If there is a modem it will be COM3 and Interrupt 5. Sometimes there are no free interrupts so you need to use the notebook hardware setup program free up an interrupt – usually by removing the sound system.

Quatech - Quad Serial Card

1. Reboot the machine and press the F8 key. Select to start from the command prompt.
2. Change to the directory with the QUATECH software.
3. Type the command:

   QSP100EN (s0,b320,i5)

were	s0	is the PCMCIA socket number (0 or 1)
	b320	is the base address for the program
	i5	s the interrupt number

   It may be necessary to modify the above parameters based on your system. See the QUATECH manual for full details.
4. When the program is executed it will display on the computer screen the base memory address and the COM port number.
5. ROMDAS needs to know the base address for the COM port (as given in 5. above with the "b320" value) as well as the interrupt number. This is entered in the **SETUP|OPTIONS|COMPORT AND PRINTING|ADVANCED COMPORT SETTINGS** screen. The QUATECH addresses go in blocks of 8 Hex from the base address (here, 320H) so the data to be entered are:

		Address	IRQ
Comm Port 1	:	03F8	4
Comm Port 2	:	0320	5

© 2001 Data Collection Ltd.

Comm Port 3	:	0328	5
Comm Port 4	:	0330	5
Comm Port 5	:	0338	5

The values for Comm Port 1 are the defaults for the internal Comm port on the computer. The values for 2 – 5 are for the QUATECH board as defined above.

COM 5 may only be used for uni-directional communications (GPS, gyroscope, laser) and not for bi-directional communications such as the TPL and ROMDAS interface.

Some versions of the card have been made to work with the settings below. If you have set the Base address of the card to 300H (the default):

COM 2	0300
COM 3	0308
COM 4	0310
COM 5	0318

NOTE: The ROMDAS Advanced COM port option will not show the ports using the F5 option.

Quatech - Single Serial Card

1. Reboot the machine and press the F8 key. Select to start from the command prompt.
2. Change to the directory with the QUATECH software.
3. Type the command:

   SSP100EN

   The software should recognise the card and display the COM port. If the card is not found try changing the PC Card sockets. It should be noted that in the QUATECH manual they refer to Socket ports 1-8 while most computers have 0 and 1 so QUATECH socket 1 corresponds to the PC Card socket 0; 2 to the PC Card socket 1. If difficulties are encountered use the flags as described in the manual.
4. Setup the ROMDAS software to the COM port recognised by the card.

© 2001 Data Collection Ltd.

ANNEX S PREPARING A BOOT MENU FOR USE WITH ROMDAS

The computers which use ROMDAS need to run under MS-DOS. However, most users also wish to run Windows 95 applications. This can create problems since when Windows is started it often reassigns interrupts which can create problems for ROMDAS. The best way of catering for both ROMDAS and Windows 95 on a single machine is by preparing a ROMDAS boot menu. This is a simple process which entails modifying two files: **config.sys** and **autoexec.bat**. The steps involved are as follows:

1. Shut down Windows 95 to MS-DOS.
2. Type **cd c:**. This will move you to the root directory on your C: drive.
3. Type **edit config.sys**. This will start the editor. The objective is to create a boot menu in your config.sys file. Detailed notes on this process and other Windows 95 DOS options are available at http://www.algonquinc.on.ca/infosystems/macewal/dosnotes/config2.html or from the Microsoft web site.
4. It is possible to set up to 9 menu items. The following is an example of a basic menu for running ROMDAS and Windows 95. The italics in the right side are comments and should not be included.

```
[menu]                                                    These are the four menus that
menuitem=ROMDAS                                           will be available to the user.
menuitem=ROMDAS_Testing
menuitem=Windows95
menuitem=DOS
[common]                                                  These are drivers loaded for all
files=20                                                  programs
buffers=20
device=c:\windows\himem.sys /TESTMEM:OFF
dos=high,umb
[ROMDAS]                                                  This is the ROMDAS menu item.
device=c:\rs232dos\enabledo.exe com = 2 aux = 3 ireq = 5   Here, we are loading a Dual
device=c:\windows\emm386.exe RAM                          Socket IO PCMCIA serial card to
                                                          COM ports 2 and 3[1]. The card is
                                                          loaded BEFORE the emm386
                                                          command so as to reserve the
                                                          appropriate memory space.
[ROMDAS_Testing]                                          No drivers are loaded for this
                                                          menu option
[Windows95]                                               Load Windows 95 specific
device=c:\windows\emm386.exe NOEMS x=D000-D7FFF           drivers (none here)
[DOS]                                                     No drivers are loaded for this
                                                          menu option
```

5. Select **Alt F** and **Save** to save the file.
6. Select **Alt F** and **Open**. Type in a**utoexec.bat** for the name of the file to open. This is the first file which is executed on booting the PC. The following is an example of the file as follows:

[1] The following are the commands that would be used for the different PCMCIA serial cards:

Socket IO – Dual Serial	device=c:\rs232dos\enabledo.exe com = 2 aux = 3 ireq = 5
Socket IO – Single Serial	device=c:\rs232dos\enableio.exe file=c:\rs232dos\socketio.ini
Eiger	device=c:\rs232dos\pccomdos.sys com4 /beep /winbios

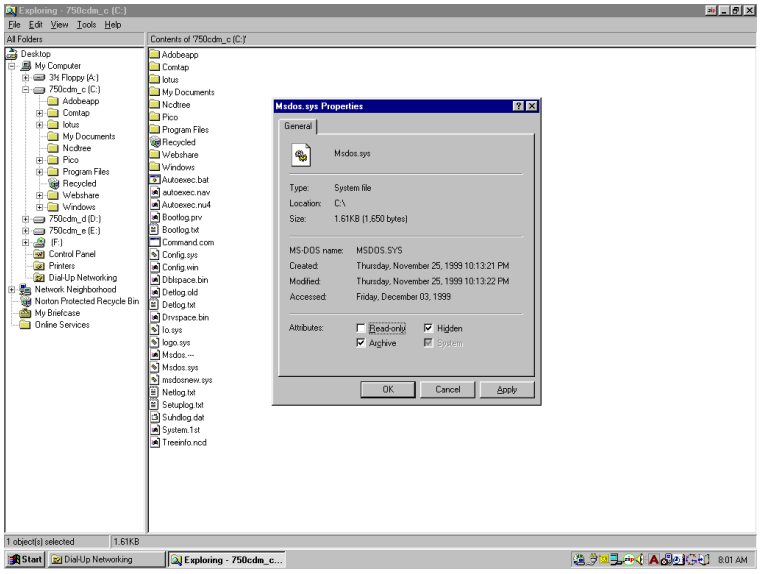
© 2001 Data Collection Ltd.

@echo off path c:\windows;c:\windows\command	*This is the basic path statement. There may be other directories*
Lh c:\windows\command\doskey.com	*This loads the utility DOSKEY. COM*
goto %config%	*Directs the menu to go to the menu item*
:ROMDAS cd \romdas romdas goto end	*This is the ROMDAS menu item. Here, we change to the ROMDAS directory, and run ROMDAS*
:ROMDAS_Testing cd \romdas romdas /t goto end	*This runs ROMDAS in test mode*
:Windows95 win goto end	*This is the Windows 95 menu item. We start Windows*
:DOS	*Starts the computer in MS-DOS mode*
:end	*This is the end of the batch file. The 'goto end' statements after each menu item skips other items*

7. Select **Alt F** and **Save** to save the file.

The final step entails telling Windows not to automatically start Windows95. This is done as follows:

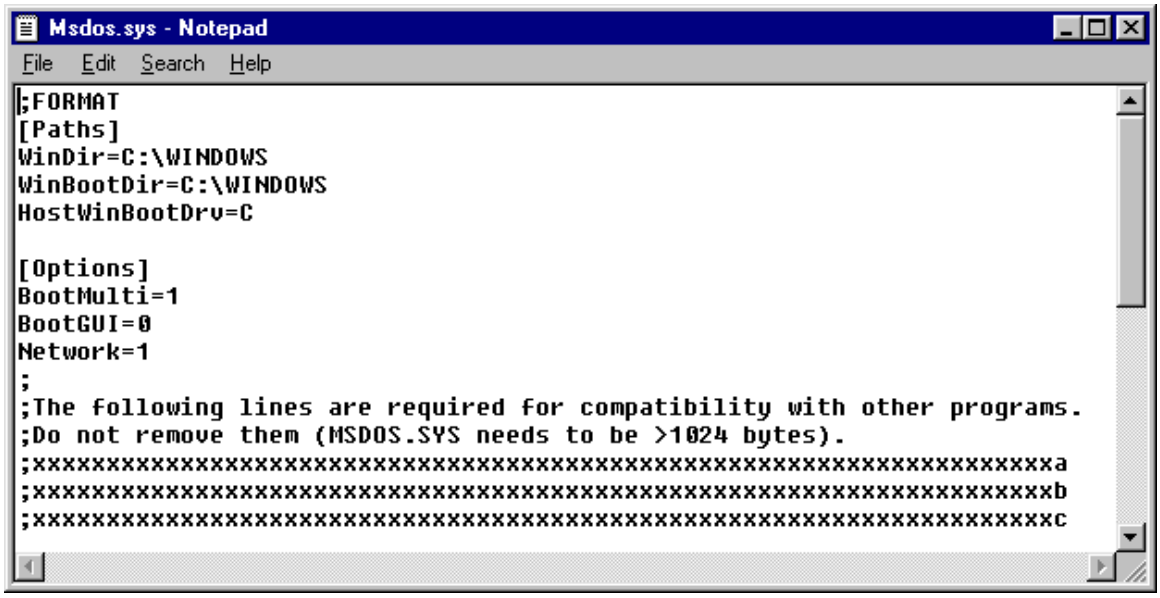
1. Open Windows Explorer.
2. Highlight the file in C:\ called **MSDOS.SYS**.
3. **Right Click** on the file and select **Properties**.
4. Under attributes click on the **Read-only** box and remove the check mark. The box should look as it does in the screen below.



5. Start Windows Notepad (**START|PROGRAMS|ACCESSORIES|NOTEPAD**).

© 2001 Data Collection Ltd.

6. Open the file **C:\MSDOS.SYS.**
7. Change the command **BootGui=1** to **BootGui=0** (see below). Also ensure that **BootMulti=1**. Save the file and restart windows. You should be given the start menu.



© 2001 Data Collection Ltd.

ANNEX T PROGRAMING THE RATING KEYBOARD

The rating keyboard works alongside standard keyboards, or as a standalone keyboard. It is designed to simplify keyboard rating by allowing for a dedicated keyboard with the rows corresponding to up to 5 different types of distresses, the columns 4 different levels of severity for each distress. Alternatively, the keys can be assigned to different inventory items, or anything that can be visually recorded.

Note: 58 Key Keyboard

The 58 key keyboard cannot be programmed using a notebook's keyboard. You must use a keyboard from a desktop computer.

The keyboard comes with a key puller. This enables you to remove the plastic caps on the keys and to label the key. Pre-printed cardboard cutouts are provided for this.

INSTALLING THE RATING KEYBOARD

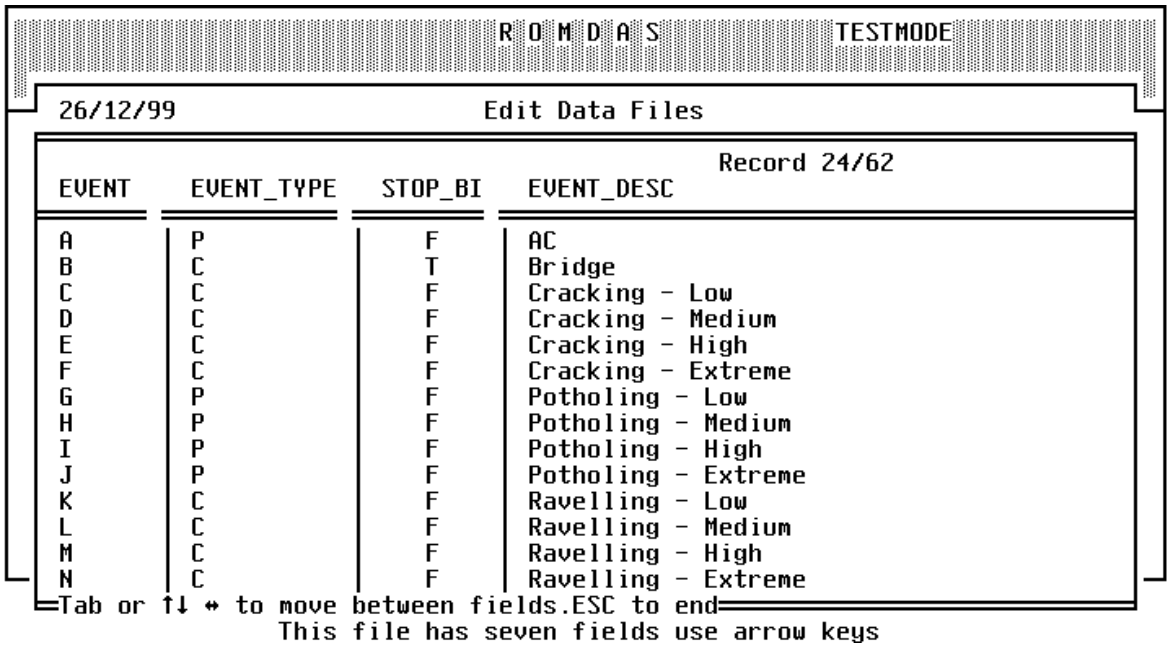
It is necessary to have an external keyboard available for programing the rating keyboard.

1. Turn off the computer.
2. Plug the rating keyboard into the notebook computer.
3. Plug the external keyboard to the rating keyboard. Alternatively, you can use a desktop computer and plug the rating keyboard into the computer and the computer's keyboard to the rating keyboard.
4. Turn on the computer and ensure that the external keyboard works.

PROGRAMING THE RATING KEYBOARD

1. Decide upon the distresses—or any other keycode events—to be assigned to the rating keyboard.
2. Decide upon the levels of severities to be used.
3. Create a ROMDAS keycode event file with these distresses and severities. An example of this is given below.
4. Slide the program switch on the right side of the rating keyboard to the program position (a red indicator will be visible to the left of the switch). **NOTE**: The red *or* green layer indicator light on the rating keyboard will blink, which lets you know that you are programing.
5. Tap on the rating keyboard the key you want to program. **NOTE**: The red or green layer indicator light will double flash.
6. Type on the external keyboard the key corresponding to the ROMDAS event key you want to program. For example, if the bottom row was to be assigned to cracking and from left to right was to be low, medium, high and extreme severities, using the example above, the letter C would be assigned to the bottom left, D to the second key, E to the third key and F to the bottom right key.
7. When the key has been entered, tap the key on the rating keyboard again. **NOTE**: The red or green layer indicator light will blink.
8. Repeat steps 5 to 7 until all the keys have been programed. Slide the program switch down to the run position. The keyboard is ready to use.
9. Test the keyboard from the MS-DOS prompt by pressing the individual keys. The letter corresponding to the ROMDAS event should be displayed.

© 2001 Data Collection Ltd.

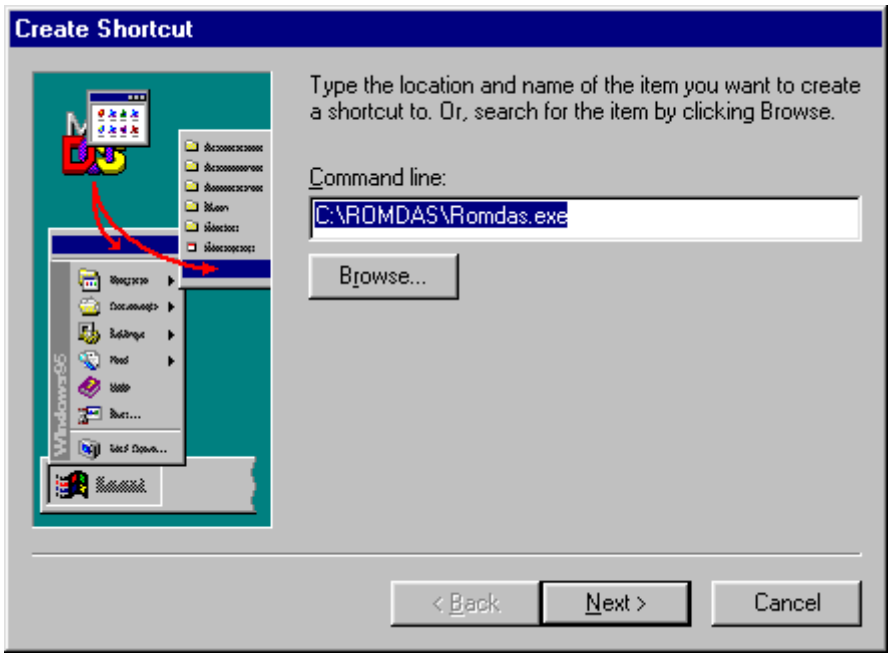

R O M D A S TESTMODE
26/12/99
Edit Data Files
Record 24/62
EVENT EVENT_TYPE STOP_BI EVENT_DESC
A P F AC
B C T Bridge
C C F Cracking - Low
D C F Cracking - Medium
E C F Cracking - High
F C F Cracking - Extreme
G P F Potholing - Low
H P F Potholing - Medium
I P F Potholing - High
J P F Potholing - Extreme
K C F Ravelling - Low
L C F Ravelling - Medium
M C F Ravelling - High
N C F Ravelling - Extreme
Tab or ↑↓ ↔ to move between fields.ESC to end
This file has seven fields use arrow keys

© 2001 Data Collection Ltd.

ANNEX U CREATING A SHORTCUT TO ROMDAS UNDER WINDOWS

When the ROMDAS software is installed to c:\ROMDAS it is necessary to manually create a shortcut to the program so it can be accessed by Windows. This is done as follows.

From Windows Explorer and select the directory where ROMDAS was installed (usually c:\ROMDAS). Select **FILE|NEW|SHORTCUT**. The window below will be presented. Type in the name **c:\ROMDAS\romdas.exe**, or if the software has been installed to another directory select **Browse**, locate the directory and double click on **romdas.exe**.


Create Shortcut
Type the location and name of the item you want to create a shortcut to. Or, search for the item by clicking Browse.
Command line:
C:\ROMDAS\Romdas.exe
Browse...
< Back
Next >
Cancel

Enter the name **ROMDAS** in the next box that is shown.

You will then be given the following screen which you can select the icon to associate with ROMDAS. Click **Finish** and the shortcut is created in the c:\ROMDAS directory.

You can then drag the icon to the start button or to the desktop.

NOTE: ROMDAS comes with a shortcut which defaults to c:\ROMDAS and this can be directly moved to the start menu.

© 2001 Data Collection Ltd.

© 2001 Data Collection Ltd.